From: Rochlin, Kevin
Sent: Thursday, July 18, 2013 7:27 PM
To: Grepo-Grove, Gina
Cc: Rochlin, Kevin; Sheldrake, Beth; Greutert, Ed [USA]
Subject: FW: RDRA UAO Deliverables
Attachments: 2013-07-15 FMC OU RD - Data Gap Work Plan.pdf; 2013-07-15 FMC OU RD - Gamma Cap Performance Evaluation Work Plan.pdf; 2013-07-15 FMC OU RD - Extraction Zone Hydrogeologic Study Work Plan.pdf

Categories: 11-19 to 1-10 2014

Gina,

Attached are 3 plans delivered to us by FMC. Each has a small QA section that I need the QA group to review. It has been a while since I have needed a QA plan looked at and so I am not sure whether there has been a more advanced system worked out for sending these to you. If possible please have these reviewed by August 16.

I am out of the office for the next month on medical leave. If you need anything on these, please call Beth Sheldrake at x0220. Please send your comments to Beth, Ed Greuter, of Booz Allen (address in the cc of the message), and to me.

Thanks.

Kevin Rochlin

From: Barbara Ritchie <BARBARA.RITCHIE@fmc.com>
Sent: Tuesday, July 16, 2013 9:07 AM
To: Rochlin, Kevin
Subject: FW: RDRA UAO Deliverables

From: Barbara Ritchie
Sent: Monday, July 15, 2013 5:36 PM
To: 'Kevin Rochlin'
Cc: 'Bruce.Olenick@deq.idaho.gov'; 'Kelly Wright'
Subject: RDRA UAO Deliverables

Kevin,

Attached, in addition to an explanatory transmittal letter, are:

1) The *Groundwater Extraction Zone Hydrogeologic Study Work Plan* (Groundwater Remedy Water Treatment Testing) required pursuant to UAO Paragraph 30.d.2.aa., submitted for EPA review and approval;
2) The Gamma Cap Performance Evaluation Work Plan (Gamma Cap Thickness Effectiveness Test) required pursuant to UAO Paragraph 30.d.2.bb., submitted for EPA review and approval;
3) The Remedial Design Data Gap Work Plan required pursuant to UAO Paragraph 30.c.6., submitted for EPA review and approval, and
4) The FMC Site-Wide Health and Safety Plan required pursuant to UAO Paragraph 30.a., submitted for EPA review.

Hard copies will be following pursuant to the requirements of the UAO.

2013-07-15 FMC OU RD - Extraction Zone Hydrogeologic Study Work Plan.pdf

FMC Idaho LLC, Pocatello, Idaho

FMC OU Remedial Design
EXTRACTION ZONE
HYDROGEOLOGIC STUDY WORK PLAN

July 2013

MWH

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LIST OF APPENDICES
(Appendices follow text)

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(Tables follow Sections)

LIST OF FIGURES
(Figures follow Sections)

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LIST OF ACRONYMS

AFLB	American Falls Lake Beds
ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COC	contaminants of concern
CWA	Clean Water Act
DQO	data quality objective
EPA	United States Environmental Protection Agency
FMC	FMC Corporation
FMC OU	FMC Operable Unit
FSP	Field Sampling Plan
ft	feet
ft/day	feet per day
gpm	gallons per minute
GWCCR	Groundwater Current Conditions Report for the FMC Plant OU
HCS	Hydraulic Containment System
I-86	Interstate 86
IROD	Interim Record of Decision Amendment
MCL	maximum contaminant level
mg/L	milligrams per liter
MWH	MWH Americas, Inc.
Plan	Groundwater Extraction Zone Hydrogeologic Study Work Plan
PM	Project Manager
POTW	publically owned treatment works
QAPP	quality assurance project plan
RA	Remedial Action
RAO	Remedial Action Objective
RBC	risk-based concentrations
RD	Remedial Design
SRI	Supplemental Remedial Investigation
SFS	Supplemental Feasibility Study
SOP	Standard Operating Procedure
UAO	Unilateral Administrative Order
WQC	water quality criteria

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1.0 INTRODUCTION

This Groundwater Extraction Zone Hydrogeologic Study Work Plan (Plan) was prepared to obtain data and information necessary to advance the Remedial Design (RD) for the FMC Operable Unit (FMC OU), Pocatello, Idaho. This Plan details the work and analyses for a detailed hydrogeologic assessment in the extraction zone of the groundwater remedial action Hydraulic Containment System (HCS) located at the northeast boundary of the FMC OU. The HCS is a component of the selected remedy for the FMC OU identified in the Interim Record of Decision Amendment (IROD, EPA 2012) and the Unilateral Administrative Order for Remedial Design and Remedial Action (UAO, EPA 2013). Data collected during this study will be utilized to refine the design of the groundwater remedy selected for the FMC OU. This Plan was prepared pursuant to Section IX., Paragraph 30.d. (Performance Testing) of the UAO and EPA's letter of June 19, 2013 that clarified the intent of the groundwater remedy performance testing.

This study will be performed to obtain more detailed hydrogeologic and water quality data within the groundwater remedy extraction zone preliminarily identified based on the *Supplemental Feasibility Study Report for the FMC Plant OU* (SFS Report, MWH 2010a) groundwater model. More detailed hydrogeologic and groundwater quality data is needed to refine the groundwater model including expected total extraction flow, number and location of extraction wells and combined water quality for purpose of evaluating water management (treatment) options. This Plan describes the collection of groundwater samples from the extraction zone for laboratory analyses and bulk water samples for potential bench-top / jar testing for further evaluation of the water treatment process for extracted groundwater, under either management option A (treatment at the City of Pocatello publically owned treatment works [POTW]) or option B (on-site treatment followed by infiltration in an on-site percolation basin[s]). A subsequent work plan may be recommended for water treatment process evaluation in the event that the bench-top / jar testing (if performed) indicates that a larger scale, on-site evaluation of the water treatment process is necessary to complete the remedial design.

1.1 BACKGROUND

1.1.1 FMC Site Description

A vicinity map of the FMC OU is provided on Figure 1-1 and a site map showing the FMC OU Remediation Areas (RAs) and hydrogeologic study area is provided on Figure 1-2.

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1.1.2 Regulatory Background

The IROD was signed by EPA Region 10 on September 27, 2012. The IROD presents the interim remedy for the Site as selected by the EPA. On June 10, 2013, EPA Region 10 issued a UAO to FMC for Remedial Design and Remedial Action (UAO; EPA 2013), EPA Docket No. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-10-2013-0116. The UAO defines the specific actions FMC will undertake to design and implement the selected remedy at the FMC OU in accordance with the IROD. The selected groundwater remedy requires extraction from the shallow aquifer to provide hydraulic containment of groundwater thereby preventing further downgradient migration of FMC OU COCs.

1.1.3 Summary of Hydrology and Hydrogeologic Setting

The EMF Site, and specifically the FMC OU, has been the subject of many environmental investigations. Most notable are the RI as summarized in the *Remedial Investigation Report for the Eastern Michaud Flats Site* (EMF RI Report; Bechtel, 1996*)*, the *Groundwater Current Conditions Report* (GWCCR) *for the FMC Plant Operable Unit* (MWH, 2009a), and the *Supplemental Remedial Investigation* (SRI) *Report for the FMC Plant Operable Unit* (MWH, 2009b). These reports provide detailed information on the results of the investigations conducted at the FMC OU. This section presents a brief summary of the hydrologic and hydrogeologic investigations, a more detailed discussion is contained in Section 2 of this Plan.

Major surface water features of the region near the FMC OU include the Snake River, Portneuf River, and the American Falls Reservoir. There are no naturally-occurring perennial surface water systems within the FMC OU. Surface water runoff from the FMC OU former operations area from precipitation is infrequent and is entirely contained within the FMC Plant Site property. Surface water runoff will continue to be entirely contained within the FMC Plant Site property during and after implementation of the selected remedy.

Groundwater at the EMF Site flows northward from the western and central portions of the FMC OU and converges with flow of groundwater from the west and northwest. Groundwater from the western and central portions of the FMC OU flows eastward, south of I-86, and joins groundwater from the Joint Fence Line Area and from the Simplot Plant. Virtually all groundwater from beneath the EMF facilities ultimately discharges to the Portneuf River between Batiste Spring and the spring at Batiste Road (aka Swanson Road Springs). Groundwater elevation contours for the shallow aquifer zone and generalized flow direction are shown on Figure 1-3.

Groundwater depths range from more than 150 feet (ft) below ground surface (bgs) in the southern portion of the FMC OU to 45 ft bgs in the northwestern area of the FMC plant area (Figures 1-4a and 1-4b; Cross Section). In the northern portion of the FMC OU, groundwater is

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approximately 60 ft bgs. The SRI sampling encountered groundwater at depths typically greater than 90 ft bgs at the FMC plant area. As presented in Figure 1-3, groundwater flow beneath the former operations area generally flows to the north from the Bannock Range and then to an east-northeasterly flow as the Bannock Range groundwater merges with the Michaud groundwater system. FMC- and Simplot-impacted groundwater discharges and mixes with the Portneuf River in the area between and including Swanson Road Spring and Batiste Spring, and then migrates into the Off-Plant OU as surface water.

1.2 PURPOSE AND OBJECTIVES OF HYDROGEOLOGIC STUDY

This Plan presents the elements for implementing a study to collect additional data that will be evaluated and incorporated in the final design of the HCS. The full-scale HCS will be designed to capture impacted shallow groundwater before it can migrate beyond the FMC Plant Site boundary. The full-scale HCS will be designed to effectively capture upgradient impacted groundwater, thus containing and extracting groundwater before it migrates off-site. The purpose of this Plan is to present the layout for the hydrogeologic study and evaluation criteria, a quality assurance project plan (QAPP) and the processes to be utilized for data reduction, review, and reporting.

The HCS will consist of a network of extraction wells, located along the northeastern boundary of the FMC Plant Site area of the FMC OU that will capture impacted shallow groundwater before it can migrate downgradient beyond the FMC OU boundary (Figure 1-3). Groundwater modeling as described in the *Groundwater Model Report for the FMC Plant Operable Unit*, (MWH, 2010b) indicates that five extraction wells will be sufficient for hydraulic capture (containment) of the remaining contaminants of concern (COC)-contaminated groundwater plume before it leaves the FMC Plant Site. During the full-scale HCS, the extracted groundwater will be treated by one of two management options: A) discharge for treatment at the City of Pocatello POTW, or B) on-site treatment followed by discharge to a percolation/infiltration basin(s) located in the western undeveloped portion of the FMC OU. This Plan details the study that FMC will conduct utilizing three extraction wells to assess the hydrogeological characteristics of soils in the planned extraction zone and the testing, data evaluation, and reporting associated with this study. The study results will be used to develop the final design of the HCS and will assist in selecting between the water management options. The final design will specify additional extraction wells (expected to total five wells) to provide complete capture of COC-contaminated groundwater.

1.3 HYDROGEOLOGIC STUDY GENERAL APPROACH AND PROCESS

Containment (i.e., hydraulic capture) of impacted groundwater near the northeast FMC Plant Site boundary is expected to be achieved by installation of a HCS and subsequent pumping of groundwater with extraction wells (see Figure 1-3). The HCS and its associated monitoring

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network will be designed and installed based on the data collected during this Hydrogeologic Study.

Predictive groundwater modeling indicates that five extraction wells, or possibly fewer, likely will be sufficient for hydraulic capture (containment) of the remaining plume before it migrates beyond the FMC OU downgradient boundary. This Plan presents a phased investigative approach prior to finalizing the design and implementation of a full-scale HCS.

1.3.1 Phase I HCS Installation

The HCS will be installed in two distinct field work phases, as necessary. Phase I will consist of the installation of three extraction wells strategically placed across an area to intercept COC-impacted groundwater (see Figure 1-3) and installation of six piezometers that will be utilized to monitor the overall containment (i.e., capture zone). Field procedures for well installation and other activities are further discussed in Section 3.0 and also detailed in Appendix A.

1.3.2 Phase I HCS Pump Tests

Variable pumping rate step-drawdown tests will be performed for a duration of approximately six hours (two hours for each of the three predetermined discharge rates as shown in Table B-3 of Appendix B, though final rates may be revised based on well development results) at each of the three extraction wells to determine specific capacity and optimal pumping rates for each well. A single 24-hour-hour constant rate aquifer test will be performed on the western extraction well to determine aquifer hydraulic parameters. Following the step-drawdown and 24-hour constant rate pumping tests, all three Phase I extraction wells will then be pumped simultaneously for a 72-hour hydraulic containment test. During the 24- and 72-hour test, the water level from select monitoring wells and piezometers will be measured and recorded. The water level data will be evaluated to determine impacts (groundwater drawdown) on the aquifer and the overall capture zone. These procedures are further described in Section 3.0 and in Appendix B. The extracted groundwater from the testing will be managed as described in Standard Operating Procedure (SOP) number 04 (Investigation Derived Waste) contained in Appendix D. In summary, if the extracted groundwater is determined to be hazardous, arrangements for off-site disposal in accordance with applicable requirements will be made. Alternatively, if determined to be non-hazardous, the water will be utilized for dust-suppression activities on site.

1.3.3 Groundwater Sample Collection

Groundwater quality samples will be collected and analyzed from the newly installed extraction wells for site COCs and potential bench-top / jar testing for further evaluation of water treatment under option A (discharge and treatment at the City of Pocatello POTW) or option B (on-site treatment followed by infiltration/evaporation). A subsequent work plan may be recommended for water treatment process evaluation in the event that the bench-top / jar testing (if performed)

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indicates that a larger scale, on-site evaluation of the water treatment process is necessary to complete the remedial design. The six piezometers and area monitoring wells located proximate to the first three extraction wells will be used to monitor water levels during aquifer tests and to provide water-level drawdown data for capture zone definition and future HCS design. This information will be presented in the Preliminary (30%) RD specified in the UAO. The monitoring and sampling locations are further specified in Section 3.0 of this Plan. Section 4.0 presents the QAPP.

1.4 HYDROGEOLOGIC STUDY WORK PLAN ORGANIZATION

The remainder of this document is organized as follows:

- Section 2.0 – FMC OU Hydrogeology and Groundwater Modeling summary
- Section 3.0 – Hydrogeologic Study design
- Section 4.0 – QAPP
- Section 5.0 – Data Reduction, Review, and Reporting
- Section 6.0 – Health and Safety Plan
- Section 7.0 – Deliverables and Schedule
- Section 8.0 – References
- Appendix A – Extraction Well and Piezometer Installation Field Procedures
- Appendix B –Procedures for Conducting Step Drawdown Tests, Constant Discharge Aquifer Tests, and Multiple Well Containment Tests
- Appendix C –Groundwater Sampling Field Form
- Appendix D – Standard Operating Procedures

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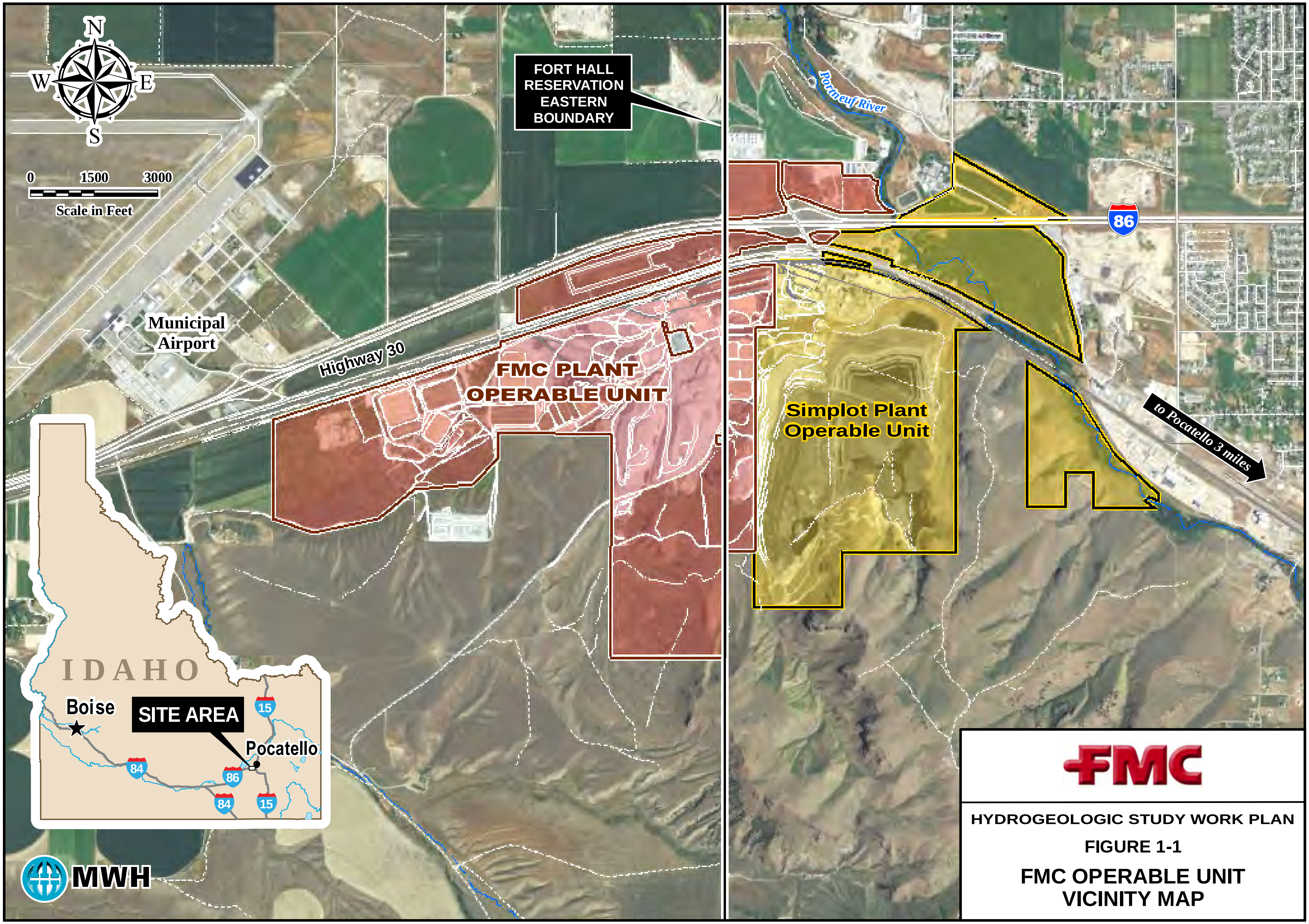
DATE: 26 June 2013

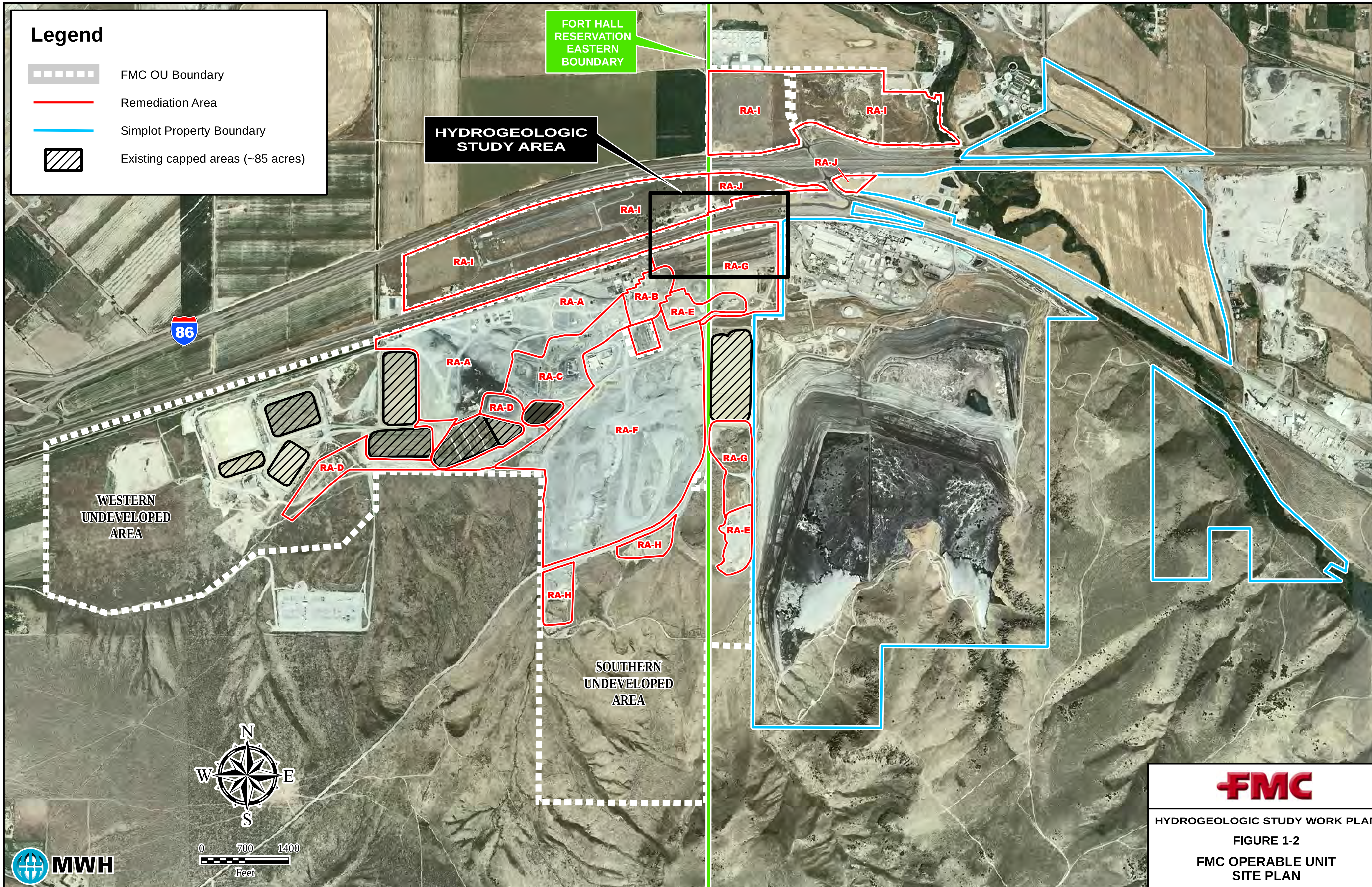


FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-1

FMC OPERABLE UNIT VICINITY MAP

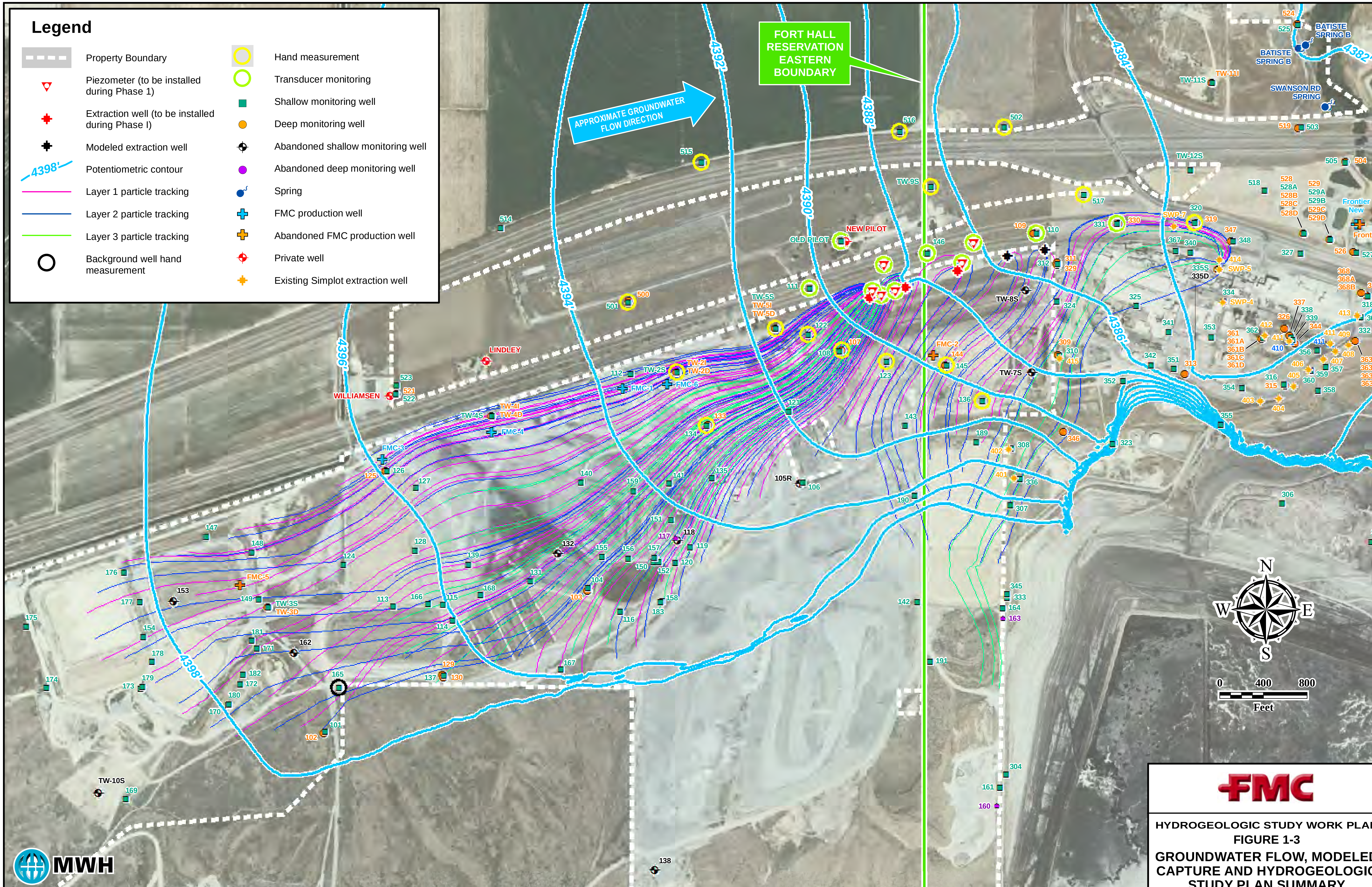


FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-2

FMC OPERABLE UNIT SITE PLAN



DATE: 15 July 2013

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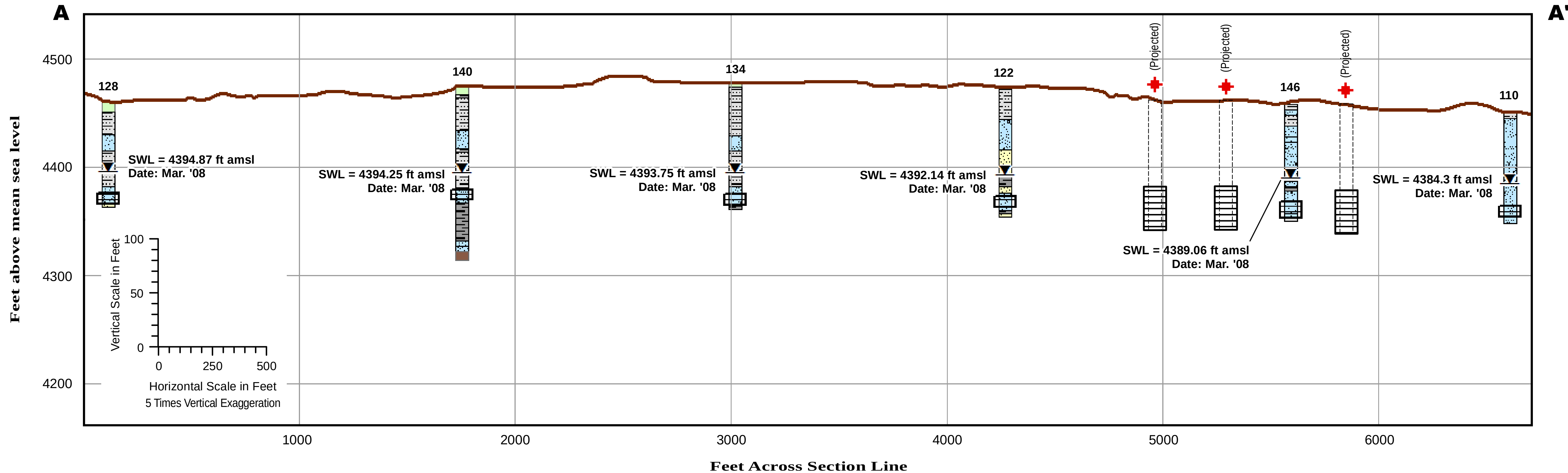

EXPLANATION

- Groundwater Level
- Well Screen Interval
- Asphalt/Fill
- Clay
- Silt
- Sand
- Gravel
- Bedrock
- Extraction Well - Phase I
- Modeled Extraction Well
- Monitoring well used for cross sections
- Cross Section Line
- FMC Property Boundary
- 4394 Potentiometric Surface Contour
- SWL Static Water Level
- ft Feet
- amsl Above Mean Sea Level

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-4a

CROSS SECTION A-A'

DATE: 15 July 2013

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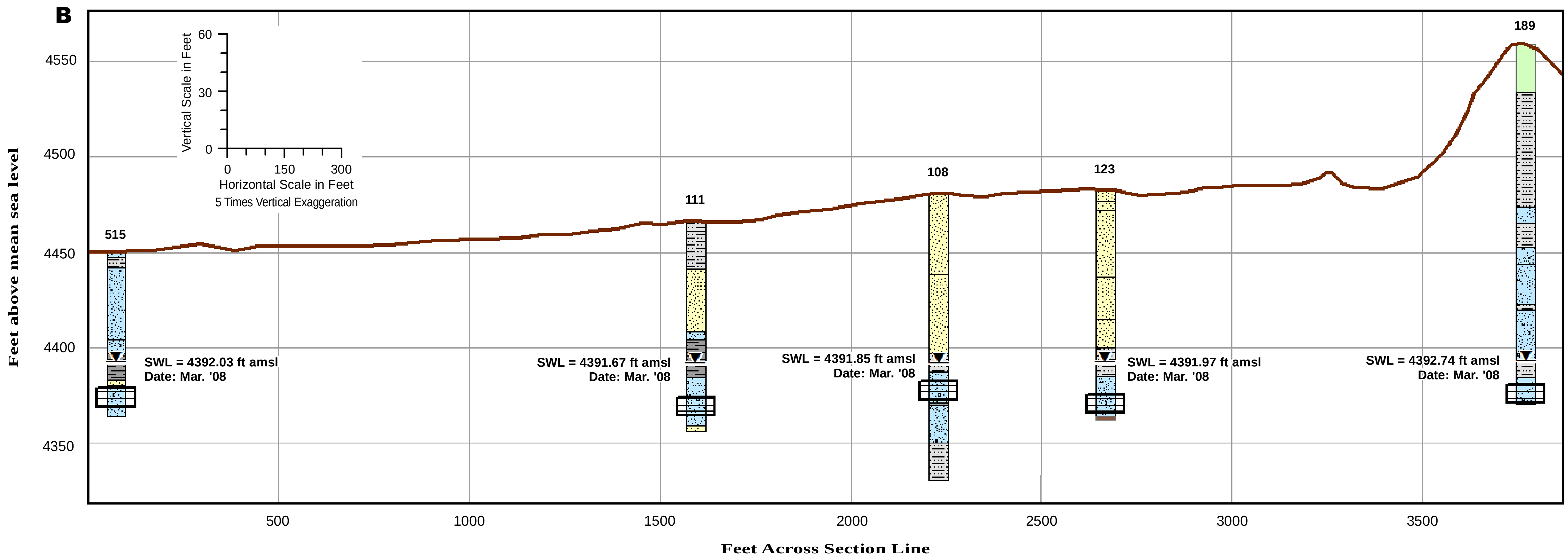

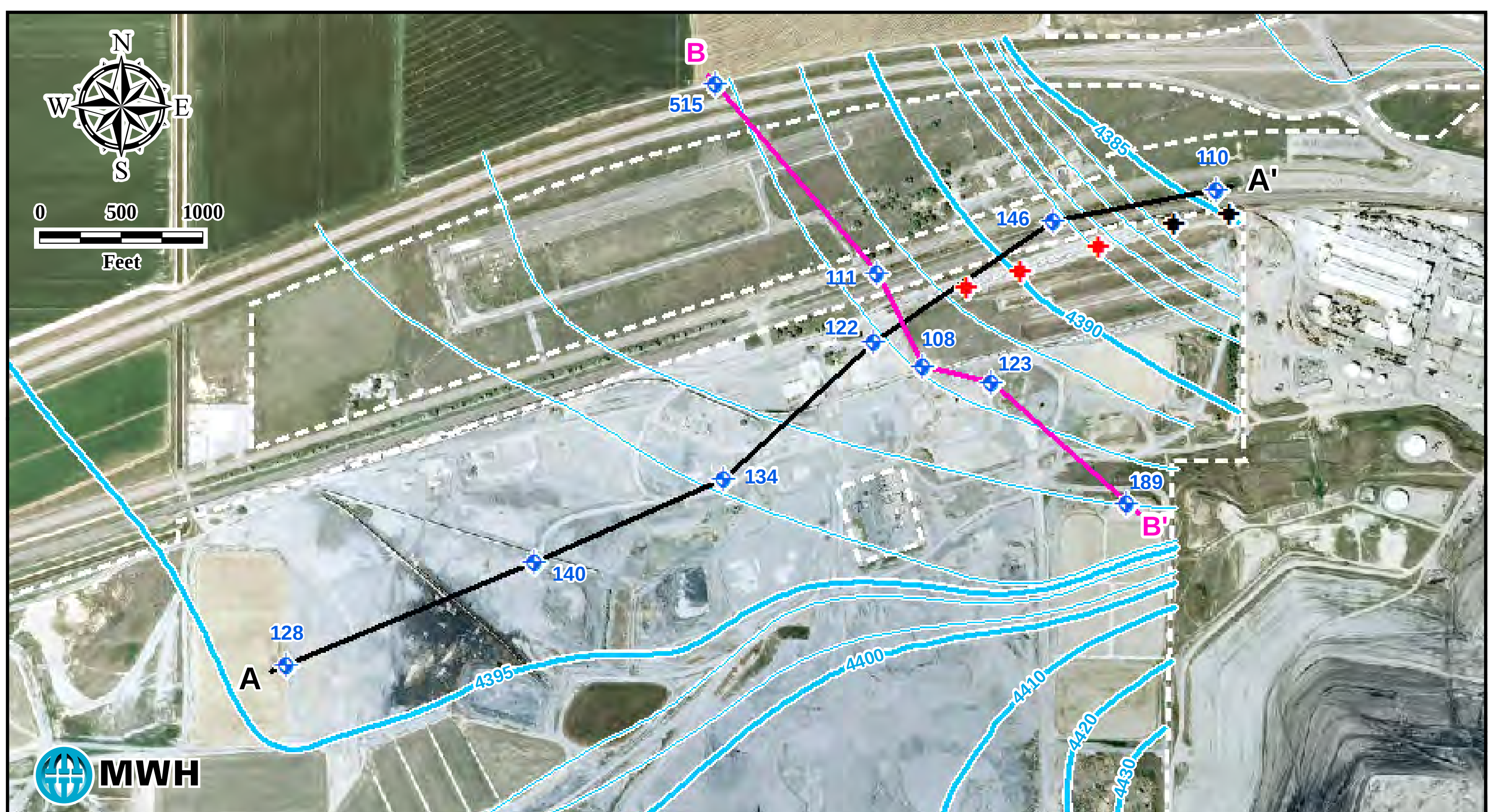

EXPLANATION

Groundwater Level	Cross Section Line
Well Screen Interval	FMC Property Boundary
Asphalt/Fill	4394 Potentiometric Surface Contour
Clay	SWL Static Water Level
Silt	ft Feet
Sand	amsl Above Mean Sea Level
Gravel	
Bedrock	
Extraction Well - Phase I	
Modeled Extraction Well	
Monitoring well used for cross sections	

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-4b

CROSS SECTION B-B'

DATE: 15 July 2013

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2.0 FMC OU HYDROGEOLOGY AND GROUNDWATER MODELING SUMMARY

This section presents a summary of the site hydrogeology, nature and extent of contamination and groundwater modeling results used to determine the initial HCS extraction well arrangement.

2.1 HYDROGEOLOGY

This section presents the geology and hydrogeology of the FMC OU. For greater detail see the EMF RI Report (Bechtel, 1996) and the GWCCR (MWH, 2009a).

2.1.1 Regional Hydrogeologic Setting

The EMF Site is located at the southern margin of the Eastern Snake River Plain which is underlain by basalt and gravel aquifers that are recharged mostly by underflow from surrounding mountain ranges. Some recharge occurs as irrigation return and deep percolation from precipitation. Several rivers flow onto the Snake River Plain, where surface water infiltrates and ultimately discharges to the Snake River. Groundwater flow through the basalts of the Snake River Plain occurs primarily in thin interflow zones: thin gravel and fracture zones between basalt flows and in the fracture of the basalts (some of the basalts are columnar basalts, with a large interconnected fracture network). Regionally, the Snake River defines the base level for some smaller rivers such as the Blackfoot and Portneuf Rivers. The Portneuf River drains approximately 1,250 square miles, flowing across the Eastern Michaud Flats to the American Falls Reservoir, where it joins the Snake River.

The Michaud Flats are underlain by the same prolific basalt and gravel aquifers. These aquifers are recharged by underflow from the adjoining Bannock and Pocatello mountain ranges and from significant down-valley underflow from the Pocatello Valley aquifer. Smaller drainages also provide underflow to the aquifers (see EMF RI Report Figure 3.3-2, provided in Appendix B of this Plan). Direct infiltration from precipitation and irrigation return are other recharge sources. Within the mountainous areas, there are no regionally continuous hydrostratigraphic units. At the transition between mountainous areas and flatlands, there are alluvial fan deposits where groundwater flow occurs primarily within sand and gravel lenses.

Within the Michaud Flats, the aquifer system can be divided into a shallow and a deeper aquifer. The shallow aquifer is the Michaud Gravel which is typically overlain by a silt aquitard. The aquitard is generally saturated from 10 to 30 feet above the gravel, but is locally unconfined. The deeper aquifer is comprised of the gravel and volcanics of the Sunbeam and Starlight Formations, and the Big Hole Basalt. The deeper aquifer is the primary water-producing aquifer within the Michaud Flats. The deeper aquifer underlies the AFLB, the regional aquitard between the shallow and deeper aquifers (Houser, 1992). Groundwater flow within the regional aquifer

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system discharges to the Portneuf River (via springs and base flow contribution), American Falls Reservoir, or to one of the numerous springs and seeps in the Fort Hall Bottoms. Groundwater discharges to the Portneuf River along the reach from I-86 downstream to the American Falls Reservoir. The river gains significant flow along this reach as groundwater discharges through the riverbed and springs on both the east and west sides of the channel. The Pocatello sewer treatment plant (STP) also contributes some flow along this river reach.

2.1.2 EMF Site Hydrogeology

The EMF Site hydrostratigraphic framework is generally consistent with the regional framework. Three distinct hydrogeologic areas were delineated in the vicinity of the EMF facilities on the basis of lithologic data, stratigraphic relationships, groundwater flow characteristics, and water chemistry. These areas are the Michaud Flats, Bannock Range, and Portneuf River (see EMF RI Report Figure 3.3-3, in Appendix B). Within the Bannock Range area there were no continuous hydrostratigraphic units delineated during the RI. Starlight Formation volcanic flows and interflow units are not correlative, and the overall distribution of rock types and saturated materials is best described as highly heterogeneous.

The transition zone between the Bannock Range hydrogeologic area and the Michaud Flats is characterized by small coalescing alluvial fans that are also relatively heterogeneous. In the Michaud Flats, distinct shallow aquifer and deeper aquifer zones were identified in the RI (see EMF RI Report Figure 3.3-4, in Appendix B). The shallow aquifer is a 10 to 20-feet thick gravel and sand aquifer that is locally overlain by a silt aquitard (EMF RI Figure 3.3-5, in Appendix B). The deeper aquifer is the gravel unit of the Sunbeam Formation and the underlying basalt and rhyolite. The unconsolidated gravel and the underlying volcanic lithologies do not appear to have a large permeability contrast, nor is there an intervening aquitard between these units. Therefore, both units constitute the deeper aquifer in the Michaud Flats area.

The AFLB form an aquitard that separates the shallow and deeper aquifers within the Michaud Flats area. These lacustrine clays and silts have very low permeability and are regionally extensive, extending from the Bannock Range area to the American Falls Reservoir, where they crop out along the reservoir embankment. The AFLB are not present along part of the Portneuf River in the area of Batiste Springs and Wells 524/525 south to Well 520 (see EMF RI Figure 3.3-6, in Appendix B). The Bonneville Flood may have scoured the AFLB, consistent with Trimble’s (1976) map of boulder deposition patterns that indicate a main flood channel in this area. Elevation contours on the top of the AFLB suggest a slight dip to the north. Just to the south of I-86, there is an elongated, east-west depression in the AFLB surface, which may also be an erosional feature of the flood (see EMF RI Figure 3.3-6, in Appendix B).

In areas immediately adjacent to the Portneuf River, where the AFLB are not present (as discussed above) and in the Bannock Range area, distinct shallow and deeper aquifers cannot be

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delineated. In the Bannock Range and Portneuf River areas, the monitoring wells in well pairs were classified as shallow and deep without respect to specific hydrostratigraphic units.

2.1.3 Aquifer Test Results

EMF Site pumping test and slug test results are detailed in Section 3.3.2.1 of the EMF RI Report (see EMF RI Table 3.3-1 Hydraulic Conductivities and Transmissivities of EMF Aquifer System, provided in Appendix B) and are summarized below.

In the Bannock Range area, hydraulic conductivity typically ranges from 0.00001 centimeter per sec (cm/s; 0.03 feet per day [ft/day]) to 0.1 cm/s (28 ft/day) in shallow and deeper zones. Although the lithology is highly heterogeneous, the hydraulic conductivity is fairly consistent throughout much of this area as defined by Wells 142, 300, 301, 304, 306, 323, 325, PEI-2, and PEI-5 (Figure 1-3). Hydraulic conductivities are higher at Wells 307, 308, and 333, which are located along the joint fenceline of Simplot and FMC. The higher hydraulic conductivities in this area are associated with a small, narrow, and deep relict sediment-filled stream channel originating within the Bannock Range (see EMF RI Figures 3.3-2 and 3.3-7A, in Appendix B).

Measured hydraulic conductivity values in the Michaud Flats shallow aquifer range from 0.01 cm/s (30 ft/day) to 0.36 cm/s (1,000 ft/day). The highest values were at Wells 150 (near Pond 8S) and 153 (near Pond 16S). Slightly lower values were associated with the depression in the AFLB, and two of the lowest values were measured in Wells 515 and 516, north of this depression. In the deeper aquifer hydraulic conductivities appear to have an increasing trend to the north. Relatively low values were measured in deeper Wells 103 and 107 with slightly higher values at Well 500 and 133.

Transmissivity data from Jacobson (1984) indicate very high hydraulic conductivities in the deeper aquifer throughout the area north of I-86 (see EMF RI Table 3.3-1, in Appendix B). South of I-86, a transmissivity of 227,000 square feet per day (ft^2/day) was calculated at Simplot production well SWP-7. When SWP-5 was installed and developed, 3 feet of drawdown was measured after 48 hours of pumping at 4,100 gpm, indicating it has a higher transmissivity than SWP-7. Irrigation wells tested in the Michaud Flats had transmissivities ranging from 21,900 to 444,000 ft^2/day (Jacobson, 1984).

The bouldery gravel aquifer in the Portneuf River area has the highest hydraulic conductivity in the area. Calculated values ranged from 0.01 cm/s (28 ft/day) to 1.7 cm/s (4,800 ft/day). Most of the slug test results from the Portneuf River area indicate hydraulic conductivities are greater than 0.36 cm/s (1,000 ft/day). Hydraulic conductivities appear to be similar in the shallow and deeper wells throughout the Portneuf River area.

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Groundwater Elevations, Flow Patterns, and Vertical Gradients. Depth to groundwater in EMF Site wells ranges from over 150 feet in the Bannock Range to less than 10 feet near the Portneuf River (groundwater reaches the ground surface at the springs). The groundwater elevations in the Bannock Range were up to 4,629 feet amsl (above mean sea level), as measured in PEI-1. Approximately 8,500 feet north the groundwater elevations were 4,383 feet amsl at Batiste Spring along the Portneuf River (see EMF RI Figure 3.3-8F, in Appendix B).

There are seasonal water level fluctuations in the Michaud Flats, typically on the order of 2 to 4 feet, which may be associated with irrigation withdrawal and recharge patterns. Overall, the water levels indicate no long-term decrease in water levels at the site. Water levels in the shallow and deep wells have typically fluctuated within 4 to 8 feet between maximum and minimum measured levels over the 15 to 18 year period of monitoring for most of the wells. Maximum water levels were generally observed in the mid- to late 1990s during a cycle of average and above average regional precipitation during the monitoring period for most wells. Minimum water levels were typically observed in the 2001 and 2002 period that coincided with several years of significantly below average precipitation in the region. Water levels have slowly rebounded in recent years but generally have not recovered to levels measured during the 1990s.

Groundwater elevation potentiometric contour plots for the shallow aquifer were prepared for each quarterly sampling event from June 1992 through May 2008. The potentiometric contour map for the shallow aquifer in May 2008 is presented in Figure 1-3. Potentiometric contour maps from June 1992 through May 2008 are provided in Appendix B of the GWCCR (MWH, 2009a). These contour patterns are very consistent from quarter to quarter and year to year. Several key features are evident in the contour patterns.

- There are very steep horizontal hydraulic gradients in the Bannock Range.
- Within the western part of the monitoring network, there is a slight northeast-trending trough in the groundwater surface extending through the area of Wells 170, 168, 139 and 140 (northeast of Pond 15S).
- There is a distinct increase in the horizontal hydraulic gradient in the vicinity of Wells 146 and TW-9S, and a decreasing hydraulic gradient further east, in the vicinity of Wells 517, TW-11S and TW-12S.
- Shallow groundwater contour patterns do not appear to be influenced by production wells pumping from the deeper aquifer nor from the dramatic decrease in pumping from production wells FMC-1 and FMC-3 following plant shutdown in December 2001.

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General flow patterns described by the hydraulic head contours indicate that groundwater flows north off the Bannock Range based on the steep hydraulic gradients observed in the low permeability materials. When this Bannock Range flow enters the highly permeable aquifer materials beneath Michaud Flats and the Portneuf River, groundwater flow converges sharply, with all shallow Bannock Range groundwater ultimately discharging along a short reach of the Portneuf River at Batiste Spring, the Spring at Batiste Road (aka Swanson Road Springs), and as bank seeps and baseflow to the river in the reach bounded by these springs just north of I-86.

Horizontal groundwater seepage velocities, calculated from hydraulic conductivities, horizontal gradients, and estimated porosity, are up to 12 ft/day in the Portneuf River area, 0.4 ft/day in the Bannock Range area, and from 1 to 11 ft/day in the Michaud Flats area. The variable seepage velocities calculated in the Michaud Flats area illustrate the effects of variable horizontal gradients and the wide range of hydraulic conductivities calculated for this area (see EMF RI Table 3.3-1, in Appendix B). The consistently high seepage velocities in the Portneuf River area are indicative of the very high hydraulic conductivities associated with the Bonneville Flood deposits.

Vertical head differentials were measured in well pairs installed during the EMF RI and during previous investigations. Vertical head differentials are one measure of the flow potential between shallow and deeper saturated zones (the other factor is the vertical hydraulic conductivity). The vertical head differentials also provide indications of the direction of the flow or gradient between shallow and deeper zones.

The overall pattern of vertical differentials shows that in the area along the flanks of the Bannock Range there is a downward vertical hydraulic gradient. Well pairs 130/137 and 101/102 had persistent downward gradients, and well pair 103/104 had a slight upward gradient (less than 0.10 foot head differential). This pattern is still observed based on the water levels at well pairs 101/102, 130/137 and 103/104 measured during May 2008. Water levels measured in May 2008 for site-wide shallow/deep well pairs are shown on Table 2.2-1 of the GWCCR. Further north, vertical gradients were upward in well pairs 134/133, 117/118 (now abandoned), 107/108, TW-5S/TW-5I, and 500/501 during the EMF RI. During the EMF RI, there was a downward gradient measured in well pair 125/126, located near production well FMC-1, which draws water from the deeper aquifer and may have induced a local downward gradient. However, based on measurements in May 2008, the slight (less than 0.1 foot) downward gradient at well pair 125/126 does not relate to pumping of FMC's production well FMC-1, as this well has not been pumped in over eight years.

From the area along the joint facilities' fenceline out to the Portneuf River, there were relatively large upward vertical head differentials measured in the well pairs 309/310, 329(311)/312, 109/110, 319/320, TW-11I/11S, 504/505, 503/519, and 315/316 during the EMF RI. In these well pairs the water levels in the deeper wells were typically 2 to 6 feet higher than water levels

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in the shallow wells. The May 2008 water level measurements at well pair 109/110 showed the water level in the deeper well (Well 109) was 4.6 feet higher than the shallow well (Well 110) with a calculated upward vertical gradient of 0.09 feet per foot, consistent with the EMF RI findings in this area of the site.

2.1.4 Summary of Groundwater Hydrogeology

- Hydraulic gradients (and inferred groundwater flow directions) within the EMF study area are very stable and have not changed significantly, as demonstrated by 18 years of quarterly monitoring.

- Migration of site-related constituents from the shallow groundwater zone to the deeper zone is inhibited by upward vertical hydraulic gradients and the presence of confining strata (silt and clay units of the AFLB) throughout large portions of the EMF study area.

- Northward flow of impacted groundwater from the western ponds area (i.e., Pond 8S and the old phossy ponds including Ponds 3E - 6E, now beneath the RCRA lined and capped ponds Pond 15S and Phase IV Ponds) and central plant areas of the FMC Plant Site is limited to the area south of I-86, due to the effects of converging flow of groundwater from the Michaud aquifer to the west and northwest.

- Virtually all groundwater underflowing the EMF facilities discharges to the Portneuf River at Batiste Spring, the Spring at Batiste Road (aka Swanson Road Springs), and as bank seeps and baseflow to the river in the reach bounded by these springs.

2.2 SUMMARY OF GROUNDWATER MODELING

A groundwater model was constructed for the FMC OU and presented in the *Groundwater Model Report for the FMC Plant Operable Unit*, (MWH, 2010b). The final calibrated groundwater flow and transport model and predictive simulations of remedial alternatives (e.g., refinement of the groundwater remedial alternatives such as extraction well locations and flow rates; assumptions regarding the J.R. Simplot Plant OU sources and sinks) were modified based on agency feedback and guidance obtained during these meetings. The groundwater model was constructed and predictive simulations were performed in four general steps as follows:

1. The three-dimensional groundwater flow model was developed and refined during calibration to provide the underlying flow regime for contaminant fate and transport simulations;

2. The contaminant transport model was developed for the site related groundwater constituents arsenic, total phosphorus / orthophosphate, and potassium and refined during calibration (plume matching) to improve estimates of transport parameters;

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3. The modeled groundwater remedial alternatives 2 and 3 extraction well configurations and pumping rates were developed and refined to meet appropriate capture and well drawdown criteria; and,

4. The predictive simulations were performed for Alternatives 1, 2 and 3.

Below is a brief summary of results from the groundwater model report:

- The calibrated steady-state groundwater flow model developed for the site adequately represents flow conditions at the FMC Plant OU, as illustrated by the simulated potentiometric surface contour map and the calibration statistics presented in the model report.

- Plume matching results indicate that the parameters selected for both the groundwater flow and contaminant transport models were reasonable and provided an acceptable match between observed and predicted plume configurations. Overall, the calibrated transport model was most sensitive to changes in sorption coefficients and relatively insensitive to changes in dispersivity and porosity.

- The selected groundwater remedy (Alternative 2 in the model report) requires hydraulic containment of contaminated groundwater at the FMC Plant Site boundary. Many well configurations (alignment and number of wells) and extraction rates were tested, until an optimal configuration was found that minimized extraction rates while still completely capturing on-site contaminated groundwater.

2.3 SELECTED GROUNDWATER REMEDIAL ACTION MODEL RESULTS

The objective of the groundwater remedy selected in the IROD and required under the UAO (Model Groundwater Alternative 2) is to contain contaminated groundwater so that it does not migrate outside the FMC OU boundary. Many well configurations (alignment and number of wells) and extraction rates were modeled, until an optimal configuration was found that minimized extraction rates while still completely capturing on-site contaminated groundwater. Based on the modeling, the final extraction well system is expected to consist of five wells (depths will be range from approximately 120 feet bgs in the western portion of the extraction area to 140 feet bgs in the eastern portion) along the northern FMC Plant Site boundary, with a total extraction rate of 530 gpm. Containment was assessed by placing MODPATH particles within the footprint of the arsenic plume (largest plume) in the three uppermost layers and tracking them forward**.** Figure 1-3 presents the extraction well alignment and particle tracking showing containment of on-site contaminated groundwater for Alternative 2. This simulation also included infiltration of 440 gpm (the estimated infiltration rate for Alternative 2B presented in Appendix C of the Groundwater Model Report; MWH 2010b) to the western undeveloped

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area of the FMC OU to simulate the disposal of treated, extracted groundwater to a percolation/evaporation pond upgradient (west) of the groundwater contamination.

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3.0 HYDROGEOLOGIC STUDY DESIGN

This section presents a description of the main components of the Hydrogeologic Study. The QAPP for this study and the groundwater sampling procedures are contained in Section 4. Field procedures for the installation of the extraction wells and piezometers and aquifer (pump) tests are contained in Appendices A and B, respectively. Standard operating procedures (SOPs) relevant to the field activities to implement this work plan are contained in Appendix D. The SOPs provided were previously developed for the supplemental remedial investigation for the FMC OU and were modified as needed for the RD field studies.

3.1 PRELIMINARY HYDROGEOLOGIC STUDY DESIGN

This section provides a discussion of the preliminary (Phase I) design of extraction wells and piezometers, including installation, construction, and testing. Design of the HCS including additional extraction wells (a total five based on preliminary modeling), a control/treatment building, and a discharge pipeline to the City of Pocatello POTW (Option A) or on-site infiltration gallery (Option B) will be presented in the RD upon completion of test analyses.

Groundwater model results indicate that installation of five groundwater extraction wells at a spacing of approximately 350 to 500 feet will create hydraulic containment and prevent further migration of the contaminated groundwater plume beyond the FMC Site northern boundary. The approximate locations (final locations to be determined in the field) of the extraction wells and piezometers is shown on Figure 3-1. The design of the extraction wells and piezometers are described below.

3.1.1 Extraction Wells

Each extraction well will be constructed in a 12-inch diameter borehole drilled to approximately 120 feet bgs (the approximate depth of the bottom of the shallow aquifer zone and the top of the AFLB aquitard), actual depths of each well will likely vary. The intent of the extraction wells is to provide control (i.e., vertical and horizontal) of COC-impacted groundwater. Each extraction well will be constructed using six-inch diameter well material (i.e., well screen and casing). Also, a one-inch diameter piezometer will be co-installed (nested) within the 12-inch borehole, adjacent to the six-inch extraction well material (Figure 3-2).

The boreholes will likely be advanced using a casing advance drilling method that will be specified by the selected drilling subcontractor. Potential methodologies include roto-sonic, triple-wall air-percussion, or ARCH drilling. The extraction wells will consist of six-inch stainless steel wire-wrapped screen extending approximately 30-40 feet above the bottom of the borehole, with six-inch diameter, schedule 80 PVC casing extending from the top of the screen to the ground surface (refer to Figure 3-1). Stainless steel well screen and PVC pipe were

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selected because of their very low corrosion rates and dielectric compatibility. The sand pack around the extraction well screen will be selected based on screen slot size and lithology, and will consist of a silica sand pack that will prevent the migration of fine soil particles into the well. For the purposes of this preliminary design, it is assumed that 10/20 mesh sand will be used for the filter pack and will extend a minimum of five feet above the well screen. Above this will be a minimum five-foot thick bentonite seal and Portland Type A cement/bentonite grout seal to within eight feet of the ground surface. The area above the concrete seal will be completed with native fill to allow for future installation of the remaining wellhead completion hardware (e.g., power conduit, transmission piping, valves, gauges, etc.). The wells will be constructed following the procedures described in Appendix A.

To facilitate the initial aquifer tests, the top of the well will be temporarily finished with a PVC flanged end and a blind flange cover that can be padlocked for security. Following aquifer tests, this temporary completion will be replaced with a concrete collar, lockable steel protective casing and barriers to protect the wellheads.

3.1.2 Extraction Well Co-Installed Piezometers

Each six-inch diameter extraction well will have a one-inch diameter internal piezometer co-installed within the boring to allow the system operator to determine the water level within the well using a pressure transducer. The internal piezometers will have approximately 40-foot long PVC screen of the same slot size as the extraction well screen (refer to Figure 3-1). Because each piezometer only needs to be large enough to accommodate a dedicated pressure transducer or a ¾-inch diameter water-level probe, it will be constructed of one-inch diameter, schedule 40 PVC casing. The top of the piezometer will be temporarily finished with a lockable watertight cap for security until final extraction well construction is completed.

3.1.3 Extraction Well Surface Completions

A protective metallic casing will be placed over each extraction well. In addition, each extraction well will have an appropriate number of barriers (e.g., Jersey barriers) to protect the wellheads. Each well and protective casing will be constructed to protrude above the ground surface, approximately 24 and 30 inches respectively. Each extraction well will be finished by placing soil around the well and sloped away from the wellhead to prevent surface water from ponding near the well.

3.2 GROUNDWATER PIEZOMETERS

In addition to the piezometers installed at each extraction well (i.e., within the same borehole), independent piezometers will be installed to monitor water levels in the immediate vicinity (within approximately 50- 300 feet) of the HCS extraction wells (Figure 3-1). These piezometers will be installed as the extraction wells are installed. As part of Phase I for the

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aquifer test and hydraulic containment test, six piezometers will be installed adjacent to the first three extraction wells and used to measure drawdown during the aquifer test and hydraulic containment test (Figure 1-3). Data from these locations will be used to determine hydraulic parameters of the aquifer including hydraulic conductivity, transmissivity, storativity, and specific yield. The piezometer arrangement will allow for the use of distance-drawdown methods as well as time-drawdown methods in the determination of these parameters. Furthermore, the arrangement will allow for delineation of anisotropy and heterogeneities within the subsurface soil strata and aquifer. Water-level data recorded during the hydraulic containment test will assist in siting additional piezometer pairs for design of the HCS system.

3.2.1 Field Procedures

The SOPs for installing extraction wells and piezometers including associated surface completion, development, and soil sampling and classification are presented in Appendix A. In addition, associated field forms that will be used for well installation are included in Appendix A.

3.3 AQUIFER TESTING NETWORK AND PROCEDURES

Variable pumping rate step-drawdown tests (i.e., six-hour step-tests, consisting of three two-hour steps) will be performed at each of the three Phase I extraction wells to determine well specific capacity and optimal pumping rates for each well. A 24-hour constant rate aquifer test will be performed on the western extraction well to determine aquifer hydraulic parameters. All three extraction wells will then be pumped simultaneously for a 72-hour hydraulic containment test. The extracted groundwater from the Phase I aquifer testing will be contained in storage tanks and characterized as described in SOP 4 (Investigation Derived Waste) contained in Appendix D. If determined to be non-hazardous, the water will be utilized for dust-suppression activities on site.

The procedures for performing the step-tests, the constant rate pumping, and hydraulic containment test are outlined in Appendix B. Certain of the existing monitoring wells (listed in Table 3-1) will be used to monitor groundwater elevations during the pumping tests.

3.4 AQUIFER TESTING ANALYSIS AND MODEL UPDATE

Data collected during the hydraulic containment testing will be used to develop hydrologic characteristics of the aquifer in the vicinity of the extraction wells. Water level measurements collected from the Phase I extraction wells, nearby piezometers, and more distant monitoring wells, will be imported into industry standard analytical software (e.g., AQTESOLV®) for analysis. Several different analytical methods (analytical methods may include Cooper-Jacob, Theis, Distance-Drawdown, and others) will be utilized to derive transmissivity, hydraulic conductivity and storage coefficients for the aquifer. Based on the results of the aquifer testing

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analysis, the capture zone will be evaluated using an analytical model for prediction of long-term performance of the extraction wells as part of the HCS.

Aquifer characteristics derived from the Phase I aquifer testing analysis will subsequently be used to update/refine the existing numerical groundwater flow model of the site. The numerical model will be calibrated to the observed performance of the aquifer during the 24- and 72-hour hydraulic containment test. Calibration of the model in the vicinity of the extraction wells may require grid refinement in order to simulate the measured groundwater drawdown more precisely. The revised numerical model will then be used to assess the potential long-term (100-year) performance (drawdown, hydraulic gradient, and flow net) of the initial three extraction wells. Results from these simulations will be used to determine if the three extraction wells meet the performance objectives of the HCS design. If additional well(s) are deemed necessary, the model results will be used to assist in selecting the appropriate locations of any additional extraction wells to meet the performance objectives of the HCS. Additional simulations may also be performed to assess and optimize the pumping distribution among the extraction wells to improve the performance of the HCS.

3.5 GROUNDWATER MONITORING AND SAMPLING AND ANALYSIS DURING AQUIFER TESTING

3.5.1 Water Level Measurements

Water level measurements will be collected from select piezometers and monitoring wells during the hydrogeologic study. Table 3-1 and Figure 1-3 provide a description of the piezometers and monitoring wells to be used to collect water level data during the tests. The measurement frequency and monitoring method (i.e., hand measurement or transducer) used at each monitoring point will vary, based on distance from the pumping well. Specifics on measurement frequency and method are provided in Appendix B.

3.5.2 Groundwater Sample Collection

Discrete time-composite and bulk groundwater samples will be collected from the installed extraction wells during the hydrogeologic test. Groundwater samples will be collected from each extraction well via an inline sample port installed in the discharge line. Table 3-2 provides a description of the HCS baseline effluent analytes, analytical test methods, reporting limits, and the precision and accuracy required to refine the expected average extracted groundwater quality to further evaluate the disposal method (i.e., disposal at the Pocatello POTW and/or on-site treatment) during design. Bulk groundwater samples (multiple 5-gallon containers) will also be collected during the aquifer (pump) tests. The bulk samples will be retained for potential utilization by third-party vendors for bench-top treatment testing in the event that an on-site treatment facility is required. Groundwater samples for chemical analysis and bulk bench-scale

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treatability study will be collected, as applicable, from each extraction well and as a composite of the HCS as follows:

- Six-hour step-test (discrete samples from each extraction well)
    - Start of six hour step test (approximately one hour after start of step one)
    - End of step three (prior to pump shut-down)
- 72-hour pump test (composite and bulk samples)
    - Start of 72-hour pump test (approximately one hour after start)
    - End of 36-hour period
    - End of pump test (72-hour period)

Groundwater sample field and laboratory analytical procedures are described in Section 4.

Table 3-1

SUMMARY OF PIEZOMETRIC SURFACE ELEVATION MEASUREMENTS
Extraction Zone Hydrogeologic Characterization Study for the FMC OU
(Page 1 of 2)

Location Identification Number	Baseline piezometric surface elevation (ft msl)	0-20 minute piezometric surface elevation (ft msl)	20-40 minute piezometric surface elevation (ft msl)	40-60 minute piezometric surface elevation (ft msl)	1-2 hour piezometric surface elevation (ft msl)	2-12 hour piezometric surface elevation (ft msl)	greater than 24 hour piezometric surface elevation (ft msl)
EW-1	X	X	X	X	X	X	X
EW-2	X	X	X	X	X	X	X
EW-3	X	X	X	X	X	X	X
PZ-01	X	X	X	X	X	X	X
PZ-02	X	X	X	X	X	X	X
PZ-03	X	X	X	X	X	X	X
PZ-04	X	X	X	X	X	X	X
PZ-05	X	X	X	X	X	X	X
PZ-06	X	X	X	X	X	X	X
107	X	--	X	X	X	X	X
108	X	--	X	X	X	X	X
109	X	X	X	X	X	X	X
110	X	X	X	X	X	X	X
111	X	X	X	X	X	X	X
122	X	--	X	X	X	X	X
123	X	--	--	X	X	X	X
133	X	--	--	--	--	--	X
134	X	--	--	--	--	--	X
136	X	--	--	--	--	X	X
144	X	--	--	--	--	X	X
145	X	--	--	X	--	X	X
146	X	X	X	X	X	X	X
311*	X	--	--	--	X	X	X
312*	X	--	--	--	X	X	X
329*	X	--	--	--	--	X	X
330*	X	X	X	X	X	X	X
X	--	--	--	--	--	X	X
500	X	--	--	--	--	--	X
501	X	--	--	--	--	--	X
502	X	--	--	--	--	--	X
515	X	--	--	--	--	--	X
516	X	--	--	--	--	X	X

Table 3-1

SUMMARY OF PIEZOMETRIC SURFACE ELEVATION MEASUREMENTS
Extraction Zone Hydrogeologic Characterization Study for the FMC OU
(Page 2 of 2)

Location Identification Number	Baseline piezometric surface elevation (ft msl)	0-20 minute piezometric surface elevation (ft msl)	20-40 minute piezometric surface elevation (ft msl)	40-60 minute piezometric surface elevation (ft msl)	1-2 hour piezometric surface elevation (ft msl)	2-12 hour piezometric surface elevation (ft msl)	greater than 24 hour piezometric surface elevation (ft msl)
517	X	--	--	--	--	X	X
TW-9S	X	--	--	--	--	X	X
TW-2S	X	--	--	--	--	X	X
TW-2I	X	--	--	--	--	X	X
TW-2D	X	--	--	--	--	X	X
TW-5S	X	--	--	--	X	X	X
TW-5I	X	--	--	--	X	X	X
TW-5D	X	--	--	--	X	X	X
319*	X	--	--	--	--	--	X
320*	X	--	--	--	--	--	X
TW-11S	X	--	--	--	--	X	X
Old Pilot	X	X	X	X	X	X	X
TW-11I	X	--	--	--	--	X	X
165 (control well)	X	--	--	--	--	X	X

* Wells are Simplot wells and may not be accessible during pump tests

ft

msl

Highlighted locations will contain pressure transducers; hand-measurements will only be collected as backup as practicable.

See Table B-1 for measurement frequency.

TABLE 3-2

GROUNDWATER FIELD MEASUREMENT AND LABORATORY ANALYSIS REQUIREMENTS
HYDROGEOLOGIC STUDY WORK PLAN FOR THE FMC OU

Parameter	Instrument / Method	Calibration	Calibration Frequency	Estimated Accuracy*	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
Field Measurements							
Depth to Water (feet)	Electrical Water Probe Steel Tape	Reference to Steel Tape Reference to New Tape	Periodically Periodically	0.1 ft 0.01 ft	66.9	NA	NA
Specific Conductance (µmhos/cm)	Conductivity meter	Daily, single standard (typically 1413 µmhos/cm)	Daily	± 0.5% or 1 µmhos/cm	1521.7	NA	NA
Redox (mV)	ORP meter	Daily, using ORP buffer solution; solution temperature must also be recorded	Daily	± 20 mV	-100.0	NA	NA
Temperature (C)	Temperature meter	Factory calibration only	Factory only	0.15 °C	16.1	NA	NA
Nephelometric turbidity (NTU)	Turbidity meter	Daily, check against 2 known standards	Daily	± 2%	2.9	NA	NA
pH	pH meter	Daily, 2- or 3-point with standard buffers (4, 7, 10)	Daily	± 0.2 pH unit	7.01	6.5 to 8.5	6.0 to 10.0

Parameter	Analytical Method Number	Method Type	Reporting Limit (mg/l)	Estimated Accuracy*	Precision **	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
WQP								
Fluoride	9056 (b) or 340.2 (c)	Ion Chromatography or Potentiometric, Ion Selective Electrode	0.1	75% - 125%	± 30%	0.30	4	32
Nitrate	9056 (b) or 353.2 (d)	Ion Chromatography or Colorimetric	0.1	75% - 125%	± 35%	6.63	10	NA
Total Phosphorus	6010B (a) or 365.2 (c)	Inductively Coupled Plasma / Mass Spectrometry or Colorimetric (ascorbic acid)	0.02	75% - 125%	± 30%	2.54	NA	7.0
Sulfate	9056 (b) or 375.4 (d)	Ion Chromatography or Turbidimetric	1	75% - 125%	± 30%	168	250	NA
Potassium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.1	75% - 125%	± 30%	43.4	NA	NA
Chloride	9056 (b) or 325.3 (c)	Ion Chromatography or Titrimetric	1	75% - 125%	± 30%	136.3	250	NA
Total Ammonia (NH3 + NH4 as N)	350.3 (d)	Potentiometric, Ion Selective Electrode	0.2	75% - 125%	± 30%	0.17	NA	NA

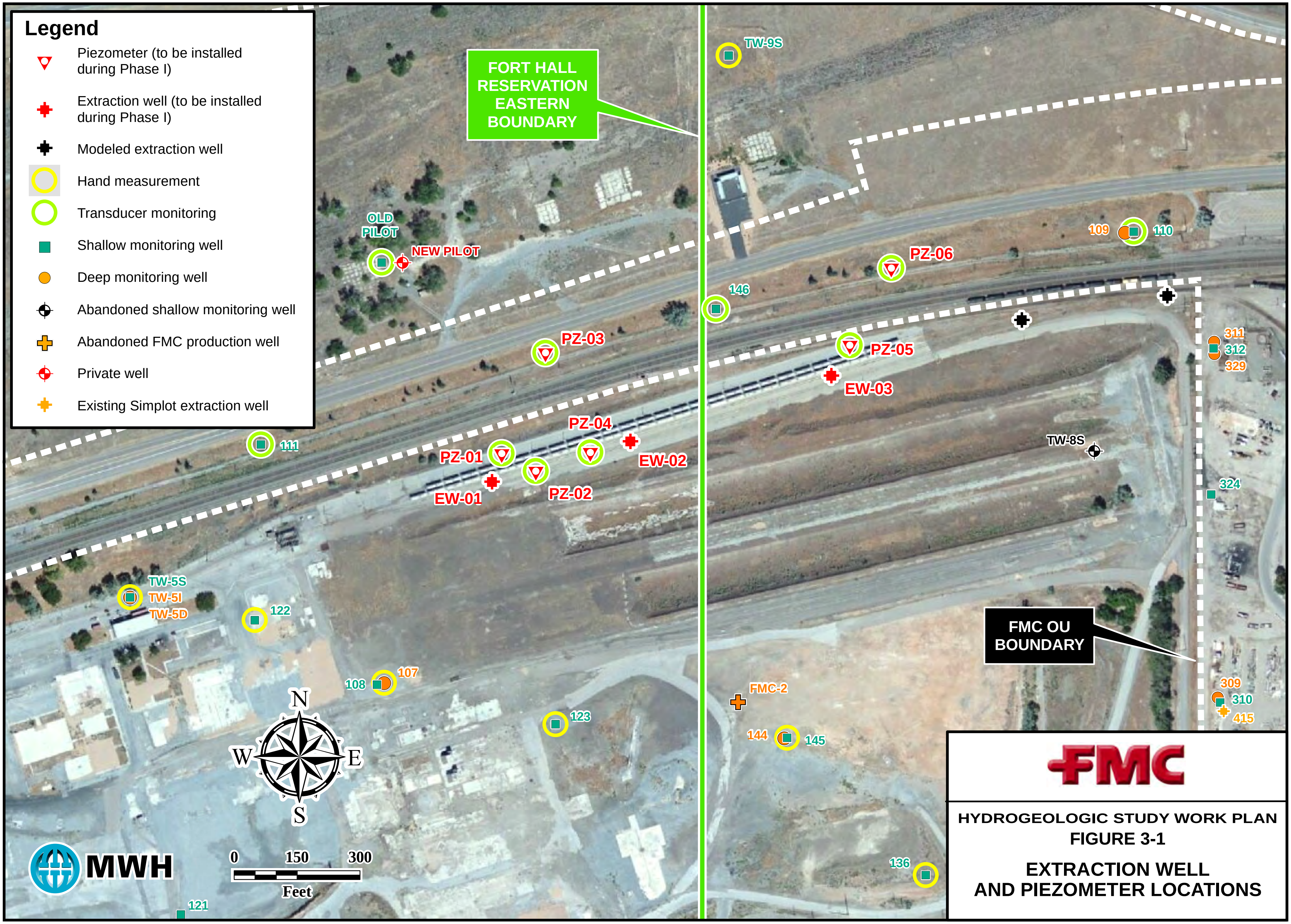
TABLE 3-2

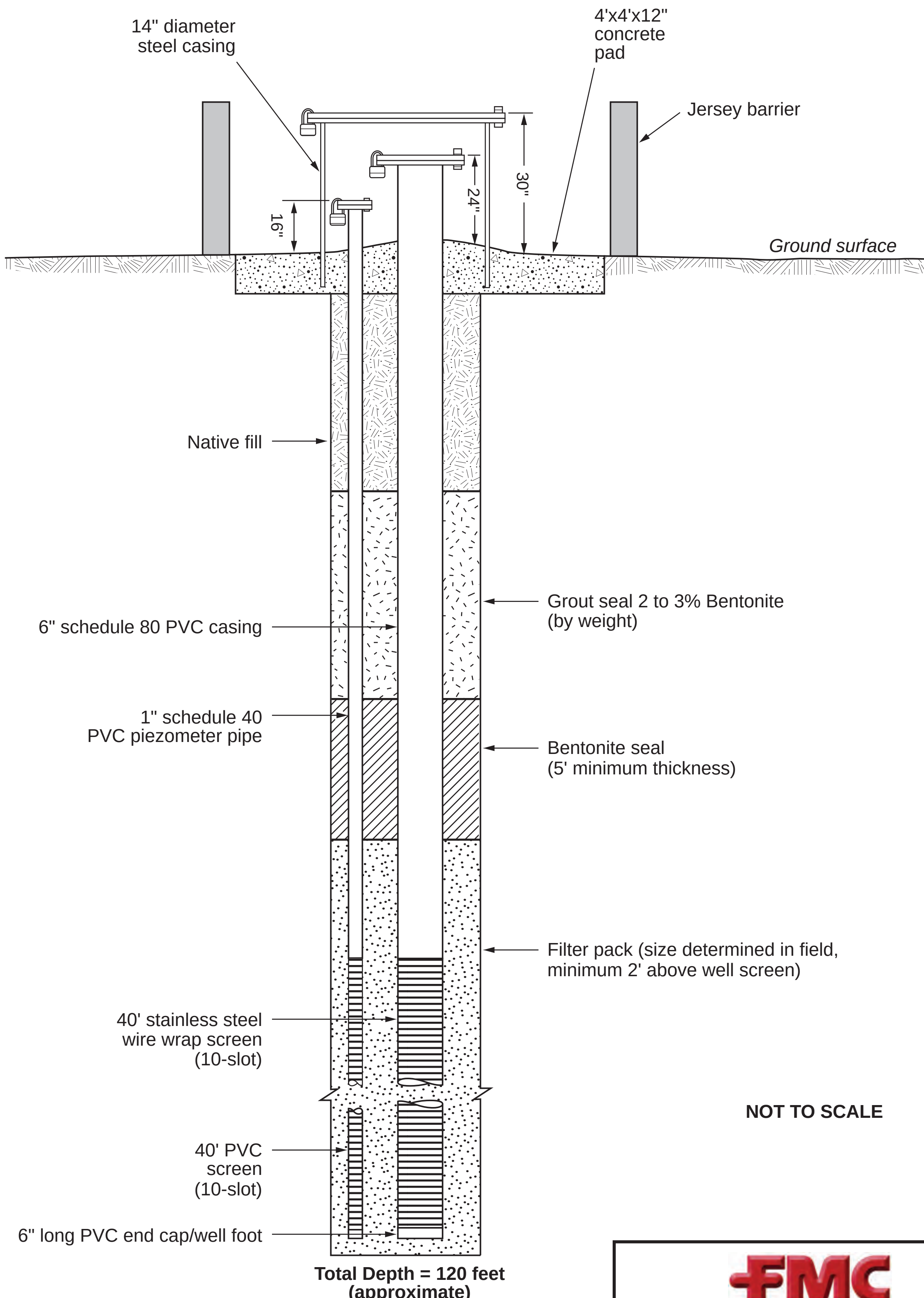
GROUNDWATER FIELD MEASUREMENT AND LABORATORY ANALYSIS REQUIREMENTS
HYDROGEOLOGIC STUDY WORK PLAN FOR THE FMC OU

Parameter	Analytical Method Number	Method Type	Reporting Limit (mg/l)	Estimated Accuracy*	Precision **	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
Metals (mg/l)								
Arsenic	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.002	75% - 125%	± 30%	0.03	0.01	0.06
Cadmium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.002	75% - 125%	± 30%	<0.0005	0.01	0.2
Copper	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	0	1	0.5
Cyanide	335.4 (d)	Colorimetric	0.01	75% - 125%	± 30%	0.01	0.2	0.2
Lead	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	0	0.015	0.3
Mercury	SW 7470A (b)	Cold Vapor Atomic Absorbtion Spectrometry	0.0005	75% - 125%	± 20%	<0.0002	0.002	0.0006
Nickel	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	<0.04	0.73	1
Selenium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.0005	75% - 125%	± 30%	0.012	0.050	NA
Silver	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	<0.005	0.1	0.6
Zinc	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.02	75% - 125%	± 20%	0.001	71	1.2

(a) Analysis may also be performed using method 6020, both 6010 and 6020 from Test Methods for Evaluating Solid Waste, EPA SW–846, Third Edition, Update IIIB, as revised through 2002.
(b) Test Methods for Evaluating Solid Waste, EPA SW–846, Third Edition, Update IIIB, as revised through 2002.
(c) Methods for Chemical Analysis of Water and Wastes, EPA600/4–79–020, Revision, March 1983.
(d) Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100).
* percent recovery
** relative percent difference
*** Secondary Standard per National Secondary Drinking Water Regulations; MCL means Maximum Contaminant Level per National Primary Drinking Water Regulations; PRG means Preliminary Remedial Goal for Tap Water per EPA Region VI PRG Table (3/8/2008), except Lithium PRG is from the Region IX PRG Table (2004); TT Action Level means Treatment Technique action level per the National Primary Drinking Water Regulations.
NA Not Applicable; no POTW standard

FILE: I:\projects\FMCidaho\FMC_Hydrogeologic Study WP\FIGURES\Fig 3-1_Extract Well and Piez Locs.mxd DATE: 15 July 2013





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HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 3-2

GENERALIZED EXTRACTION WELL DESIGN

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4.0 QAPP AND FSP

4.1 INTRODUCTION

This section presents the QAPP and the Field Sampling Plan (FSP) for the Hydrogeologic Study and includes:

- Project team and project organization;
- Data Quality Objectives (DQOs);
- Field measurement and sampling procedures
- Equipment calibration procedures
- Sample preservation and handling procedures; and,
- Personnel training.

4.2 PROJECT TEAM AND ORGANIZATION

The responsibility and authority of each team member in this project organization is presented below.

4.2.1 EPA Remedial Project Manager

The EPA is the lead agency governing the remediation of the FMC OU. The EPA issued the IROD and UAO, and is responsible for approving all plans and reports related to implementing the Selected Remedy, including the Hydrogeological Study. The EPA Remedial Project Manager is Mr. Kevin Rochlin.

4.2.2 FMC Project Coordinator

As the responsible party, FMC is implementing the Selected Remedy in accordance with the UAO. FMC has overall responsibility for procuring consultants and contractors to perform the work, budgeting and securing the necessary funds, and assuring that the requirements of the UAO are met. The FMC Remediation Director is Ms. Barbara Ritchie.

4.2.3 MWH Project Director

Mr. Marc Bowman is the MWH Project Director and main point of contact for MWH Americas, Inc., the Supervising Contractor. Mr. Bowman was the MWH Project Manager (PM) for the FMC Plant OU SRI/SFS and will have overall responsibility for successful completion of the RD and the Hydrogeological Study. He will be responsible for the contractual commitments and for ensuring that the necessary resources are dedicated to the project, will define/clarify the scope of work and objectives for each major activity, and will assure the technical, budget, and schedule requirements are met.

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4.2.4 MWH RD Manager

Mr. Rob Hartman is the MWH RD Manager and will be responsible for day-to-day technical elements of the Hydrogeological Study. Mr. Hartman, along with the MWH Project Director, will be responsible for coordinating with the necessary agencies and authorities to identify any permit requirements associated with implementation of the remedy.

4.2.5 MWH Hydrogeological Manager

Mr. Jesse Stewart will serve as the MWH Hydrogeologic Manager and serve as the primary interface to the MWH Project Director and the RD Manager. He will be responsible for coordinating the necessary resources to accomplish the Study elements and to complete the Hydrogeological Study testing on schedule as well as providing construction quality assurance.

4.3 DATA QUALITY OBJECTIVES

During execution of the Hydrogeologic Study there are two types of data to be collected:

1. Physical measurements (e.g., groundwater elevations) associated with aquifer pumping tests; and,

2. Groundwater chemical analyses of groundwater samples collected from study area extraction wells.

The Data Collection Quality Objectives for the Hydrogeological Study are presented in Table 4-1.

4.3.1 Extraction Well and Piezometer Installation

There is no “problem statement” or “decisions” associated with the installation of the extraction wells and piezometers during the execution of this Plan. Thus, no specific, numeric data quality objectives (DQOs) have been established. Thus, no specific, numeric data quality objectives (DQOs) have been established. However, the use of qualified field personnel (geologists/hydrogeologists), adherence to the Extraction Well and Piezometer Installation Field Procedures detailed in Appendix A, and field documentation will assure the wells/piezometers will be installed properly and will meet the requirements for this hydrogeologic study and completing the design and ultimately the full-scale implementation of the HCS.

4.3.2 Aquifer Pump Test Physical Measurements

The pump test physical measurements that will be collected are direct measurements and there is no “problem statement” or “decisions” associated with the data. Thus, no specific, numeric data quality objectives (DQOs) have been established. As specified in the Procedures for Conducting

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Step Drawdown Tests, Drawdown Tests, Constant Discharge Aquifer Tests and Multiple Well Containment (Appendix B) , manual water-level measurements shall be collected using electronic water-level indicators capable of measuring to 0.01-foot accuracy during all segments of the aquifer test. Electronic water-level indicators will be dedicated to specific wells during the test to avoid errors due to slight differences between indicators. Manual water-level measurements shall be collected as a back-up to water-levels measured using pressure transducers and data loggers.

4.3.3 Groundwater Samples - Field and Laboratory Analyses

The objective of the sampling and analyses is to collect samples of groundwater from the extraction wells that are representative of the expected combined, extracted water quality of the full-scale HCS for the purpose of further evaluating the groundwater management options A (discharge to the Pocatello POTW) and B (on-site treatment and discharge to a percolation pond(s)) .

The groundwater field parameters will be measured utilizing calibrated field meters with the calibration frequency and accuracy specified on Table 3-2.

The groundwater samples from the extraction wells will be analyzed at a NELAP-accredited analytical laboratory for the parameters specified on Table 3-2. The acceptable level of uncertainty is included in Table 3-2 as accuracy and precision goals. Samples will be collected and handled as described in Section 4.4.2 below. The specified reporting limits are below the lower of the groundwater cleanup standard or Pocatello POTW Pretreatment Limit to assure the data are useable.

4.4 SAMPLING/MEASUREMENT PROCEDURES

4.4.1 Extraction Well and Piezometer Installation Procedures

The methodologies and procedures for installation of the extraction wells and piezometers are presented in Appendix A.

4.4.2 Aquifer Test Procedures

The methodologies and procedures for performing the aquifer testing program are presented in Appendix B.

4.4.3 Groundwater Sampling Procedures

As described in Section 3 and shown on Table 4-1, three types of groundwater samples will be collected during this study:

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1. Discrete samples for laboratory analysis collected at the start (approximately one hour after the start) of the six-hour step drawdown test at each extraction well;
2. A composite sample for laboratory analysis that includes aliquots collected at the start (approximately one hour after the start), after 36 hours and at the end of the 72-hour multi-extraction well containment pump test; and
3. Composite ("bulk") samples that include aliquots collected at the start (approximately one hour after the start), after 36 hours and at the end of the 72-hour multi-extraction well containment pump test to be retained for potential bench / jar testing by water treatment equipment / supply vendors.

The procedures for collecting, labeling and handling these samples is described below.

4.4.3.1 Sample Designation

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples will have pre-assigned, identifiable, and unique ID numbers. At a minimum, the sample labels will contain the following information:

- Facility name.
- Sample number.
- Date of collection.
- Time of collection.
- Analytical parameter.
- Method of preservation.

4.4.3.2 Sample Collection

The discrete groundwater samples will be collected directly from the pump tubing (at each extraction well) into the appropriate sample containers, preserved as described below, and chilled and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the discharge tubing to the sample container.

The composite sample will initially be collected in an approximately 5-gallon pre-cleaned container. An aliquot from each extraction well will be collected at the time intervals specified above and on Table 4-1. The volume of the aliquot from each well will be in proportion to the pump rates set for each well during the multi-extraction well containment pump test. For example, if well EW-1 is pumping at 120 gpm, well EW-2 at 100 gpm and EW-3 at 80 gpm, then the aliquot volume from EW-1 and EW-3 will be 20 percent greater and lower, respectively than

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the aliquot from well EW-2. As nine (9) total aliquots will be collected in a 5-gallon container, the “base” aliquot volume will be about 0.5 gallons.

The composite groundwater sample will then be transferred into the appropriate sample containers, preserved as described below, and chilled and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the 5-gallon composite collection container to the sample container.

The same procedure described for the initial collection of the composite sample into 5-gallon containers will be used to collect the bulk samples that will be retained. Approximately eight (8) bulk samples will be collected and retained.

For the discrete and composite samples to be submitted for laboratory analysis, a separate pre-cleaned container will be filled and used to measure the field parameters. A field pH meter with a combination electrode or equivalent will be used for pH measurement. A field conductivity meter will be used for specific conductance measurements. A nephelometer-type turbidimeter will be used for turbidity measurements. Temperature measurements will be performed using standard thermometers or equivalent temperature meters. A combined field meter or individual meters will be used for dissolved oxygen and ORP measurements. Combination instruments capable of measuring multiple parameters may also be used. All instruments will be calibrated in accordance with manufacturers’ recommendations. The field parameter measurement, calibration and accuracy requirements are provide on Table 3-2.

The recommended sample containers and required sample preservation and holding times for the discrete and composite sample to be submitted for laboratory analysis are summarized in the inset table below.

Sample Preservation and Holding Time Requirements for Laboratory Analyses

Parameter	**Recommended Container**	**Preservative**	**Maximum Holding Time**
Water Quality (Cl^-, F^-, NO_3^-, and SO_4^{2-})	0.5-liter polyethylene bottle	Cool to 4°C	28 days
Metals (Ag, As, Cd, Cu, Hg, K, Pb, Ni, Se, Mn, B, V, Zn and Total phosphorus)	0.25-liter polyethylene bottles	HNO_3 to pH $\leq$ 2, Cool to 4°C	6 months; except Hg is 28 day hold time
Total Ammonia	0.5-liter polyethylene bottle	H_2SO_4 to pH $\leq$ 2; Cool to 4°C	28 days
Total cyanide	0.5-liter polyethylene bottle	NaOH to pH $\geq$ 12; Cool to 4°C	14 days

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The sample designation, field parameters and number of containers / preservation for each of the samples to be submitted to the laboratory for analysis will be documented on a groundwater sampling field form (Appendix C).

4.4.3.3 Sample Handling

All sample containers will be pre-cleaned. Preservatives, if required, will be added to the containers prior to shipment of the sample containers from the laboratory (pre-preserved) or added to the samples(s) in the field as needed to meet sample preservation requirements.

All sample containers for submittal for laboratory analysis will be placed in a strong, rigid-walled shipping container such as a heavy plastic cooler. The following outlines the packaging procedures that will be followed.

1. When ice is used, secure the drain plug of the cooler with tape to prevent melting ice from leaking out of the cooler.
2. Line the cooler with bubble wrap, as needed, to prevent breakage during shipment.
3. Check screw caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of their sample bottles with indelible ink.
4. Custody-seal all container tops.
5. Affix sample labels onto the containers and write sample number on container with indelible ink.
6. Wrap all glass sample containers in bubble wrap to prevent breakage.

All samples will be placed in coolers with the appropriate chain-of-custody form. All forms will be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap to prevent movement and breakage during shipment. Ice used to cool samples will be placed on top and around the samples to chill them to the correct temperature. Both samples and ice will be double-bagged in large plastic bags. Each ice chest will be securely taped shut with strapping tape; and custody seals will be affixed to the front and back of each cooler.

The retained bulk groundwater samples will be labeled as described above and stored at a secure location.

4.5 PERSONNEL TRAINING

All personnel directly involved with the Hydrogeological Study will be provided with a copy of this Plan. Personnel will be trained in the requirements specified herein and provided ample time to read and become familiar with these requirements prior to beginning data collection activities. All onsite personnel shall conform to the MWH health and safety plans and the FMC *Site-Wide Health and Safety Plan* (FMC 2013).

Table 4-1

Data Collection Quality Objectives
Groundwater Extraction Zone Hydrogeologic Study Work Plan for the FMC OU

(Page 1 of 2)

#	DQO Step	HCS Model Prediction Capture Zone Determination	Establish Expected Average HCS Effluent Quality to Refine Evaluation of Disposal Options
1	State the problem	Verify Model Predictions and determine the alignment and layout for the final design of the full-scale HCS to capture contaminated groundwater before if migrates beyond the FMC Plant Site.	Establish expected average effluent quality to refine evaluation of management/disposal options (i.e., discharge to the Pocatello POTW or on-site treatment and discharge to percolation basin(s)).
2	Identify the decision	Define hydrogeologic conditions in the extraction well zone identified by the groundwater model.	Expected average HCS effluent quality and total flow are needed to evaluate and determine if discharge to the POTW is viable, and to finalize design for the management/disposal option.
3	Identify inputs to the decision	Groundwater elevation (water level) data collected from select locations at and near the extraction area (see Table 3-1). Water levels will be measured to an accuracy of 0.01 foot. Groundwater pump test results will be utilized to update the groundwater model.	Groundwater samples for chemical analysis and bulk bench-scale treatability study will be collected, as applicable, from each extraction well and as an composite of the HCS as follows: **Six-hour step-test (discrete samples from each extraction well)** • Start of six hour step test (approximately one hour after start of step one). • End of step three (prior to pump shut-down) **72-hour pump test (composite and bulk samples)** • Start of 72-hour pump test (approximately one hour after start) • End of t 36-hour period • End of pump test (72-hour period)
4	Define the study boundaries	Approximate northeast boundary of the FMC Plant OU.	Groundwater in the impacted shallow aquifer zone at the northeast boundary of the FMC Plan OU.

Table 4-1

Data Collection Quality Objectives
Groundwater Extraction Zone Hydrogeologic Study Work Plan for the FMC OU

#	DQO Step	HCS Model Prediction Capture Zone Determination	Establish Expected Average HCS Effluent Quality to Refine Evaluation of Disposal Options
5	Develop a decision rule	A groundwater model update will be used to determine whether the full-scale HCS can provide long-term groundwater capture at the FMC Site boundary.	The results will be used to refine evaluation of management/disposal options.
6	Specify limits on decision errors	Based on previous modeling efforts (mean absolute error), differences between simulated and observed head conditions should be less than or equal to an absolute value of 1.1 feet across the model domain.	Not applicable.
7	Optimize the design for obtaining data	Data will be collected as described in Section 3.0 and Appendix B of this Plan.	The field hydrogeologic studies and data evaluation activities will be conducted as described in this Plan.

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5.0 DATA REDUCTION, REVIEW AND REPORTING

5.1 DATA REDUCTION

Data collection for the Hydrogeologic Study will be performed in the field and analytical laboratory. Field data will be used as reported from properly calibrated water level meters and pressure transducers. Analytical data will be provided by the analytical laboratory.

5.2 DATA REVIEW, PERFORMANCE AUDITS AND CORRECTIVE ACTIONS

Prior to use, the MWH RD Manager or designee will review and assess the quality of field data. The data will be reviewed to assess whether the procedures specified in this Work Plan, including the QAPP and FSP, were followed and to identify inconsistencies and/or anomalous values. Any inconsistencies will be resolved immediately, if possible, by seeking clarification from those personnel responsible for data collection. At a minimum, the information contained in field logs/notes, field-sampling forms, instrument outputs, as applicable, will be included in the review process. All changes or corrections to this field documentation will also be reviewed. A narrative will be prepared that describes any deviations from the procedures, explains any qualifications regarding the data quality, and describes any significant problem identified during the review process.

As the field portion of the hydrogeologic study is expected to be completed within three to five weeks, construction quality control measurements will be field audited at least twice during the field effort.

5.3 DOCUMENTATION AND REPORTING

All data collected in direct support of this gamma cap performance evaluation will be retained by FMC and/or its contractors consistent with the records retention requirements under the UAO. All data collected in direct support of this extraction area hydrogeologic characterization study will be reported to EPA in a report entitled *Hydrogeologic Study Summary Report* to be provided within 60 days of completion of the field work or receipt of final validated laboratory analytical reports, whichever is later. This will allow time for data interpretation and processing as well as an update to the groundwater model.

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6.0 HEALTH AND SAFETY PLAN

The FMC Plant OU is covered by the *Site-Wide Health and Safety Plan* ([SWHASP], FMC 2013). The SWHASP provides the Site health and safety organization, specific Site hazards, Site controls, Site evacuation procedures, Site PPE requirements, general health and safety procedures, and emergency procedures. In addition, the SWHASP requires that all Contractors working on the Site will develop their own action-specific Health and Safety Plan (HASP) which will incorporate the general requirements specified in the SWHASP. Each Contractor's action-specific HASPs must provide specific health and safety requirements that are pertinent to the anticipated activities during that action.

Per the requirements of UAO Section IX, Paragraph 30. a., FMC will submit the most recent version of the SWHASP under a separate transmittal. Copies of the SWHASP and all Contractor action-specific HASPs will be maintained on Site during actions performed under this Work Plan.

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7.0 DELIVERABLES AND SCHEDULE

In addition to this Plan and the SWHASP (as described in Section 6.0), a report entitled *Hydrogeologic Study Summary Report* will be provided within 60 days of completion of the field work or receipt of final validated laboratory analytical reports, whichever is later.

The overall hydrogeologic study project schedule is as follows:

Project Activity	**Schedule**
Submittal of the *Site-Wide Health and Safety Plan*	45 days after EPA approval of Supervising Contractor (per UAO Appendix C).
Submittal of *Hydrogeologic Study Work Plan*	60 days after EPA approval of Supervising Contractor (per UAO Appendix C).
Mobilize for implementation of field work	10 days after final approval of the *Hydrogeologic Study Work Plan.*
Complete field work	75 days after mobilization / implementation of field work.
Submittal of the *Hydrogeologic Study Summary Report*	60 days after completion of field work or receipt of final validated laboratory analytical reports, whichever is later.

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8.0 REFERENCES

Bechtel, 1996. Remedial Investigation Report for the Eastern Michaud Flat Site. Bechtel Environmental, Inc. Draft issued September 1995 and revised August 1996.

Bechtel, 2004. Remedial Investigation Update Memorandum for the FMC Plant Operable Unit. December 2004 Revision of June 2004 Draft

EPA 2012. Interim Amendment to the Record of Decision for the EMF Superfund Site - FMC Operable Unit - Pocatello, Idaho, September 27, 2012.

EPA, 2013. Unilateral Administrative Order for Remedial Design and Remedial Action, EPA Docket No. CERCLA-10-2013-0116, June 10, 2013.

FMC, 2013. Site-Wide Health and Safety Plan, July 2013.

MWH, 2009a. Groundwater Current Conditions Report for the FMC Plant Operable Unit, June 2009 - Final.

MWH, 2009b. Supplemental Remedial Investigation Report for the FMC Plant OU, May 2009.

MWH, 2010a. Supplemental Feasibility Study Report for the FMC Plant Operable Unit, July 2010.

MWH, 2010b. Groundwater Model report for the FMC Plant Operable Unit, July 2010 (Appendix E of the SFS Report).

MWH, 2010c. Interim CERCLA Groundwater Monitoring Plan for the FMC Operable Unit, July 2010.

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APPENDIX A

EXTRACTION WELL AND PIEZOMETER INSTALLATION FIELD PROCEDURES

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A.1 INTRODUCTION

This appendix describes and outlines field procedures for the installation, development, topographic survey, and groundwater elevation measurements of extraction wells, monitoring wells/piezometers for the FMC OU Hydrogeologic Study in support of the FMC OU Boundary Hydraulic Containment System (HCS).

A.2 GENERAL CONSIDERATIONS FOR WELL INSTALLATION

A.2.1 Underground Utility Locating and Digging Permits

Subsurface locations will be cleared by FMC as specified in SOP 1 provided in Appendix D. If any underground utilities are determined to be present at a proposed location, the location will be moved to the nearest area clear of utilities.

A.2.2 Well and Piezometer Designations

For the purposes of this Plan, the extraction wells, monitoring wells, and piezometers are numbered sequentially using "EX" to indicate an extraction well, "and "PZ" to indicate a piezometer (e.g., EX1, EX2 and PZ1, PZ2). As the wells and piezometers are installed during the phased process, they will be given designations that conform to FMC OU guidelines.

A.2.3 Soil Sample Collection Procedures

During drilling activities, soil samples for stratigraphic logging will be collected from the borehole prior to well installation. Soil samples will be collected either a split-spoon sampler or from soil cores (e.g., sonic drill cores). As necessary, a sample catcher will be placed at the end of the sampler so that unconsolidated soils are not lost as the sample device is retrieved from the borehole.

In the event that the HCS extraction wells and piezometers are installed using roto-sonic drilling methods, soil cores for stratigraphic logging will be collected continuously throughout the length of the borehole. However, if the extraction wells and piezometers installation is performed using other drill methods (i.e., air-rotary, etc.,) soil samples will be collected using a split-spoon sampler at 5-foot centers above the water table, and then continuously from approximately 5 feet above the saturated zone to the bottom of the boring. Split-spoon, soil samples for piezometers installed shall not be collected until drilling depths have reached approximately 5 feet above the saturated zone; at which point samples for stratigraphic logging will be collected at five-foot centers to the bottom of the borehole. Screened intervals will be selected based on stratigraphic interpretations from drilling activities.

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Stratigraphic logging will be performed at each well and piezometer location according to the Unified Soil Classification System (USCS). The USCS soil classification is based on grain size, degree of grading, stiffness, plasticity, and density. In addition, the soil description will also include Munsell color (wet), soil particle angularity, and moisture content), if present. All stratigraphic data will be recorded on the Extraction Well/Piezometer Boring Log Form (included in the field forms the end of Appendix A).

A.2.4 Decontamination Procedures

All down-hole drilling and sampling equipment will be decontaminated prior to use at each borehole location in accordance with SOP 2 provided in Appendix D. After decontamination, down-hole equipment will be kept off the ground and stored on a clean surface (e.g., plastic) until it is used. All decontamination fluids will be disposed of according to the protocols established in SOP 4 provided in Appendix D.

A.2.5 Documentation

Field activities associated with extraction well and piezometer drilling, soil sampling, construction, completion, and development will be recorded on field forms included as an Attachment to this Appendix. The MWH on-site representative will maintain a field logbook. The field logbook will be a weather resistant, bound, survey-type book, with non-removable pages. Information to be entered in the logbook typically will include the name and location of the job, personnel on site, name and address of the field contact person, the date(s) the borehole was started and completed, weather conditions, sampling methodology, sample depths, decontamination procedures, and any other observations that may be relevant to the field program.

A.2.6 Well and Piezometer Development Procedures

The extraction wells and piezometers will be developed no sooner than 48-hours after grouting and construction are completed. The extraction wells and piezometers will be developed using a combination of a surge block and bailer and either a portable centrifugal pump, a submersible pump, or airlift pump. The depth to groundwater and the total depth of the well will be measured with an electric water-level indicator prior to and immediately after development.

During extraction well and piezometer development, water quality parameters such as pH, specific conductivity, temperature, and turbidity will be monitored. These parameters will be measured with a portable water-quality meter. The parameters will be measured at the beginning of well development and after the evacuation of each borehole volume. A minimum of six rounds of water quality parameter measurements will be made; and well development will continue until the following criteria are met:

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- Five borehole volumes (assuming 30 percent porosity in the sand pack) have been removed

- Three consecutive water-quality measurements must satisfy the following criteria:

  - pH = $\pm$ 0.2 pH units

  - Temperature = $\pm$ 1°C

  - Specific conductivity = $\pm$ 10 percent

  - Turbidity <= 5 nephelometric turbidity units (NTUs).

Piezometer development will continue until the purged water is reasonably free of sediments (as determined by the MWH field representative). The total time devoted to developing each piezometer will not exceed 4 hours.

A.2.6.1 Decontamination Procedures

All down-hole equipment associated with well development will be decontaminated prior to use at each borehole location in accordance with SOP 2 provided in Appendix D. After decontamination, down-hole equipment will be kept off the ground and stored on a clean surface (e.g., plastic) until it is used. All decontamination fluids will be disposed of according to the protocols established in SOP 4 provided in Appendix D.

A.2.6.5 Documentation

All measurements made during monitoring well development will be recorded on the Well Development Form (Attachment 1). Required information includes well identification, date and time of development, field personnel, method of development, meter(s) used to measure water quality parameters, calibration procedures, measured water quality parameters, discharge rates, volume of water evacuated from the well, beginning and ending water level, total well depth measurements, and notes on any discussions to terminate development before compliance with the turbidity criteria.

A.2.7 Investigation-Derived Waste Handling

All cuttings will be stockpiled at each drill location on plastic sheeting. The cuttings will be covered at the completion of drilling activities according to SOP 4 provided in Appendix D.

All groundwater and decontamination water generated during well drilling, development, or pump test / sampling activities will be managed according to SOP 4.

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A.3 GROUNDWATER EXTRACTION WELLS

A.3.1 Extraction Well Drilling Equipment and Procedures

Casing advance drilling methods (e.g., roto-sonic, ARCH, triple-wall percussion) will be used to install the extraction wells and piezometers. It is anticipated that the total depths of the extraction wells will be approximately 120 feet bgs. The boreholes will have an effective diameter of approximately 12 inches. No circulating fluid, drilling muds, or other additives will be used without pre-approval of the Project Managers. Additives are not expected to be required.

A.3.2 Extraction Well Design and Construction

A.3.2.1 Extraction Well Design

The extraction wells will be constructed of six-inch diameter, flush-threaded, Schedule 80, polyvinyl chloride (PVC) casing connected to flush-threaded sections (30-40 feet total) of stainless steel wire-wrapped screen, with a stainless steel end cap. Each extraction well boring shall also contain a co-installed 1-inch diameter, Schedule 40, PVC piezometer pipe. The extraction well and associated piezometer screened sections will consist of 0.010-inch factory slotted screen. The sand pack around the extraction well and associated piezometer screen will be placed as the well is installed, and will consist of a silica sand pack (i.e., 10/20 mesh sand) that will prevent the migration of fine soil particles into the well. The screen in each extraction well and associated piezometer will be placed according to field observations, and extend approximately 40 feet above the bottom of the well.

A.3.2.2 Extraction Well Construction

Extraction well construction will be initiated within 18 hours of completing the borehole. To ensure the stability of the borehole during well construction, the extraction well will be constructed through the drill string. It is anticipated that each extraction well will be constructed with the bottom of the screen located at approximately 120feet bgs. Refer to Figure 3-1 in Section 3.0 for the extraction well design and completion details.

After the well casing and the capped screens have been positioned, and suspended with centralizers, to the desired depth in the borehole (e.g., extraction well and associated piezometer), a sand-pack consisting of clean, , non-carbonate silica sand will be placed in the annulus between the screen and borehole wall as the drill casing or drive pipe are slowly removed. As the drill casing or drill string are pulled upward, and the sand settles out through the bottom, additional sand will be added so that no less than one-foot of sand always remains inside the bottom end of the drill string during sand pack construction. The depth of the sand

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pack inside the annular space between the casings and the borehole wall will be continuously monitored using a weighted probe. The sand pack will be added until it is a minimum of five-feet above the screens. The well will be gently surged during emplacement of the filter pack to enhance settlement and to minimize voids. After the intended sand pack height has been reached, the sand will be allowed to settle for at least 20 minutes, after which the depth of the top of the sand pack will be verified. If additional sand is required, it will be added to the borehole. The sand will once again be allowed to settle and the height of the sand pack will be verified.

After the sand pack is in place, a minimum five-foot thick bentonite seal will be placed on top of the sand pack. Bentonite pellets will be poured from the surface to the top of the sand pack as the drill casing or drill strings are slowly withdrawn. The thickness of the bentonite seal will be monitored with a weighted probe. The depth to the top of the seal will then be verified using the weighted probe. When the desired thickness is reached, clean potable water from an approved water source will be added to the borehole, and the bentonite seal will be allowed to hydrate for 30 minutes. For seals competed below the water table, wax coated bentonite tables (e.g., Pel Plug) will be used. The coated tables sink through the water column to the top of the sand pack and are “time released” during hydration. The bentonite seal will be allowed to hydrate for 30 to 45 minutes.

The remaining open annular space of the extraction well will be grouted to eight-feet bgs through a tremmie pipe positioned at the bottom of the annular space. The PVC risers will extend approximately two-feet above the ground surface.

A.3.2.6 Extraction Well Completion

The above ground PVC well casing will be protected from vehicular damage by using Jersey barriers to cordon-off a 10-foot by 10-foot array around each well head until the final completion is installed. For all extraction wells a 14-inch diameter protective steel casing approximately three-feet in length will be installed to a height of approximately 2.5-feet above the ground surface. The protective casing will have a vented lid that can be secured with a lock. A mortar collar will be placed within the protective casing annulus from the ground surface to 6 inches above the ground surface. A 0.25-inch diameter hole (drainage port) will be drilled in the protective casing, approximately 0.5 inch above the mortar collar. The mortar mix will be composed of one part cement to two parts sand. Minimal water will be used to hydrate the mix. The protective casing will then be set in a minimum four-foot square, 12-inch thick concrete pad that slopes away from the steel casing toward the ground surface.

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A.4 PIEZOMETERS

A.4.1 Piezometer Drilling Equipment and Procedures

Piezometers will be installed using the same manner as the extraction wells above. However, smaller diameter casing advance will be utilized (e.g., six to eight inch casing). It is anticipated that the total depths of the piezometers installed for the Hydrogeological Study will be approximately 120 feet bgs.

A.4.2 Piezometer/Monitoring Well Design and Construction

A.4.2.1 Piezometer Design

The piezometers/monitoring wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC riser connected to 2-inch diameter, flush threaded sections of Schedule 40 PVC screen, with a PVC end or cap. The screened sections of the piezometers/monitoring wells will consist of 0.010-inch factory slotted screen. The sand pack surrounding the piezometer screen will be placed as it is installed, and will consist of a silica sand pack that will prevent the migration of fine soil particles into the piezometer. The depth interval for the screen in each piezometer will be placed according to field observations. The piezometer screen will consist of 10-foot intervals and will be placed to fully penetrate the saturated thickness of the aquifer. The actual completion details will be decided in the field based on the saturated thickness of the target water-bearing zone and the requirements of aquifer tests performed during the Hydrogeological Study.

A.4.2.2 Piezometer Construction

Piezometer construction will be initiated within 18 hours of completing the borehole. To ensure the stability of the borehole during construction, the piezometer will be constructed through the drill pipe.

After the riser and the capped screen have been positioned to the desired depth in the borehole, a sand-pack consisting of clean, non-carbonate silica sand will be placed in the annulus between the screen and borehole wall as the drill string are slowly removed. As the drill string is pulled upward, and the sand settles out through the bottom, additional sand will be added so that no less than one-foot of sand always remains inside the bottom end of the drill string during sand pack construction. The depth of the sand pack inside the annular space between the casing and the borehole wall will be continuously monitored using a weighted probe. The sand pack will be added until it is a minimum of two-feet and no more than three-feet above the top of the screen. The piezometer will be surged during emplacement of the filter material. After the intended sand pack thickness has been reached, the sand will be allowed to settle for at least 20 minutes, after which the depth of the top of the sand pack will be verified. If additional sand is required, it will

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be added to the borehole. The sand will once again be allowed to settle and the thickness of the sand pack will be verified.

After the sand pack is in place, a minimum five-foot thick bentonite seal will be placed on top of the sand pack. Bentonite pellets will be poured from the surface to the top of the sand pack as the drill string is slowly withdrawn. The thickness of the bentonite seal will be monitored with a weighted probe. The depth to the top of the seal will then be verified using the weighted probe. When the desired thickness is reached, clean potable water from an approved water source will be added to the borehole, and the bentonite seal will be allowed to hydrate for 30 minutes. For seals competed below the water table, coated bentonite pellets/tablets will be used. The coated pellets/tablets sink through the water column to the top of the sand pack and is “time released” during hydration. The seal will be allowed to hydrate for 30 to 45 minutes.

A.4.2.3 Piezometer Completion

For all piezometers completed above ground, the protective steel casing will be approximately 5 feet in length and will extend to a height of approximately 2.5 feet above the ground surface. The protective casing will have a vented lid that can be secured with a lock. A mortar collar will be placed within the protective casing annulus from the ground surface to approximately 6 inches above the ground surface. Soil will be placed around the casing that slopes away from the steel casing toward the ground surface. Each well completed above ground will be protected by barriers (e.g., Jersey barriers or bollards). A stainless steel identification plate stamped with the well designation will be affixed to each well casing or flush-mount lid (if used). Refer to Figure A-2 for construction details for above-ground well completions.

Each well and piezometer will be protected at the surface by a locking steel casing. For wells or piezometers completed as flush-mounts, the protective casing will be flush with the ground surface and extend to approximately 2.5-feet below the ground surface. A well vault constructed of steel with a locking, water-tight lid will be inserted in the protective casing so that it is level with the ground surface. The vault will then be fixed in place using cement that meets the specifications of FMC. To secure the well or piezometer, the vault will be installed to accommodate a lock. Refer to Figure A-3 for construction details for flush mount well completions. The construction and completion details for each well and piezometer will be recorded on a Well Completion Form.

A.5 TOPOGRAPHIC SURVEY / GPS

All extraction wells and piezometers will be surveyed for horizontal control with Global Positioning System (GPS) equipment as specified in SOP 3 contained in Appendix D. The elevation measurements for the monitoring wells and piezometers will be made at a specific mark at the top of the riser casing (measuring point), and at the ground surface.

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The horizontal control for each GPS measurement will be within ± 3.0. The vertical control for each survey measurement will be within ± 0.01 feet.

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ATTACHMENT 1

FIELD FORMS

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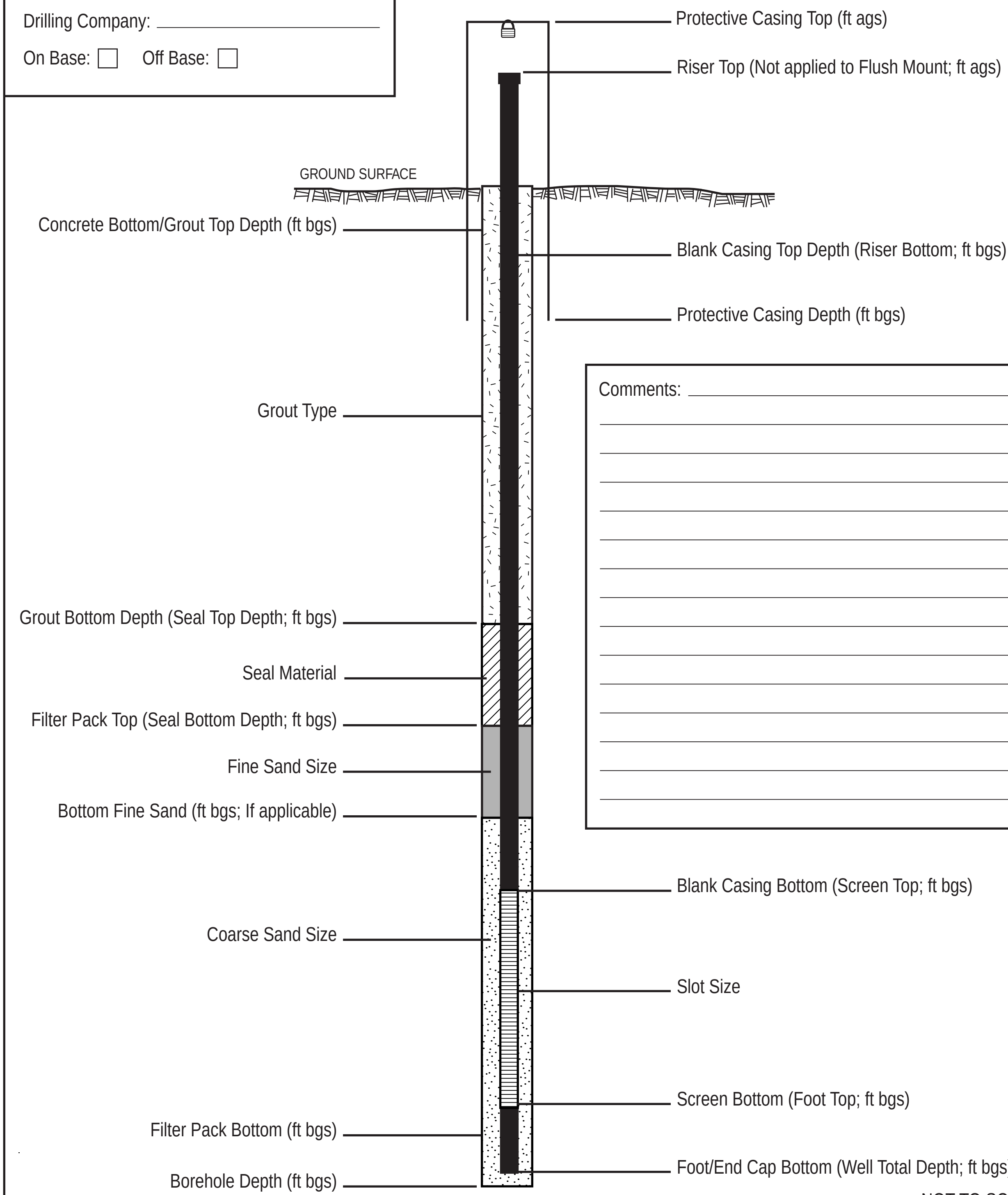
MONITORING WELL COMPLETION FORM

Project No: ______________________

Drilling Company: ______________________

On Base: ☐ Off Base: ☐



Comments: ______________________

NOT TO SCALE

Loc ID/Well ID ______________________	Blank Casing Material/Diameter __________ / __________
Geologist ______________________	Screen Material/Diameter __________ / __________
Date Construction Started ______________________	Protective Casing Type ______________________
Date Construction Completed ______________________	Borehole Diameter ______________________
LOC Type (i.e. Monitoring Well) ______________________	Above Ground Completion ☐ Flush Mount ☐
Riser Material/Diameter __________ / __________	USCS Classification of Screened Interval ______________________

PROJECT NO. __________

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MONITORING WELL LOG FORM

BORING LOCATION

Project: __________ Project No: ___________

Date Drilled: ________ Date Completed: ________

Logged By: ________________________________

Water Elevation (ft.): ________________________

Date Measured: ____________________________

Total Depth (ft.): ____________________________

Diameter (in.) _______________________________

Boring ID: ______________________

Northing:_____________ Easting:______________

Ground Surface Elevation (ft.): ________________

Measuring Point (MP) Elevation (ft.): ___________

MP is Top of PVC Casing Datum: NGVD (1929)

Drilling Contractor: __________________________

Drilling Method: _____________________________

Screen: Diameter ______________ Depth _______________ Slot Size ___________________________

Casing: Diameter ______________ Length ______________ Type ______________________________

Sand ______________ Bentonite Seal ___________________ Cement Grout Seal ___________________

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICATION	GRAPHIC LOG	LITHOLOGIC DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)

* C California Split Spoon Sampler (2.5" I.D.)

S Standard penetration test sampler

c Cuttings

▼ Elevation of ground water

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Project: ______________ Project No: ____________________
Boring ID.: _____________

DEPTH (FEET)	GRAIN SIZE			MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICAT.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)
	% GRAVEL	% SAND	% FINES								

PROJECT NO.

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MONITORING WELL LOG FORM

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MONITORING WELL DEVELOPMENT

DATE: ______________________________ WEATHER: ___________________________________

WELL DESIGNATION: __________________ PROJECT NO: _________________________________

FIELD PERSONNEL:_______________________ SUBCONTRACTOR:____________________________

WELL SUMMARY:

Depth to NAPL:_______________________

Depth of water: ______________________

Total well depth:______________________

Construction: ________________________

____

Start Time_____(a)

End Time______(b)

Total Time_____(b-a)

Location Map

INSTRUMENTATION

pH meter (model): ______________________ Calibrated with buffers: ______4 ______7 ______10

SC meter (model): __________________ Calibrated with standard solution: ____________ µmhos/cm

Turbidity meter (model): __________________ Calibrated with: _____________________________

DEVELOPMENT SUMMARY:

Development method: Bailer____________ Pump (type) _________ Surge Block (type) _________

5 purge volume calculation: ___________________________

Time	pH	SC (µmhos/cm)	Temp (°C)	Turbidity (NTU)	Pumping Rate	Gals. Evacuated	Visual Appearance/Comments

Final

Time	pH	SC (µmhos/cm)	Temp (°C)	Turbidity (NTU)	Pumping Rate	Gals. Evacuated	Visual Appearance/Comments

PROJECT NO. ______

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APPENDIX B

PROCEDURE FOR CONDUCTING STEP DRAWDOWN TESTS, CONSTANT DISCHARGE AQUIFER TESTS, AND MULTIPLE WELL CONTAINMENT TESTS

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B.1 INTRODUCTION

To prevent further downgradient contaminant migration beyond the FMC OU Site boundary, a hydraulic containment system consisting of multiple extraction wells will be installed along the northeast site boundary. Prior to full-scale implementation, a Hydrogeologic Study will be performed to collect additional hydrogeologic data from the site. As part of the Hydrogeologic Study, aquifer testing will be performed to determine aquifer hydraulic properties (e.g., hydraulic conductivity, transmissivity, storativity, specific yield, delayed yield, sustainable pumping rates, anisotropy, etc.) and to determine the potential for lowering the piezometric surface sufficiently to achieve hydraulic containment. This Plan outlines the methods that will be used to 1) perform 6-hour step-drawdown tests at each extraction well installed to determine specific capacities and sustainable pumping rates, 2) a 24-hour test at the western most extraction wells for determining hydraulic properties using a constant rate aquifer test, and, 3) a 72-hour constant rate pump test at the three initial extraction wells pumping simultaneously to determine whether hydraulic containment is being achieved. This work plan addresses the requirements and logistics associated with these aquifer tests.

B.2 OVERVIEW OF PUMPING TESTS

This section details the following elements of pumping tests:

- Aquifer test principles
- Assumptions and limitations
- Test method selection
- Equipment requirements
- Personnel requirements.

B.2.1 Aquifer Test Principles

Several different types of aquifer tests can be conducted to determine aquifer properties, although the fundamental principles of all tests remain similar. An aquifer test is performed by applying stress to an aquifer by extracting groundwater from a pumping/extraction well and measuring the aquifer response to that stress by monitoring drawdown as a function of time in the pumping well, and/or observation wells or piezometers, at known distances from the well. These measurements are then incorporated into an appropriate well-flow equation to calculate the hydraulic properties of the aquifer.

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B.2.2 General Assumptions and Limitations for Pumping Tests

Numerous different types of aquifer tests and well-flow equations exist that may be implemented for a variety of hydrogeologic settings. Each method has a different set of limitations and assumptions. Separate assumptions and limitations exist for confined, semi-confined (leaky), and unconfined (water-table) aquifers. In general, the following assumptions apply to most well-flow equations and hydrogeologic settings:

- The aquifer is of infinite areal extent;
- The aquifer is of uniform thickness;
- The aquifer is approximately horizontal over the area that shall be influenced by the pumping test;
- The aquifer is pumped at a constant discharge rate; and
- The pumping well fully penetrates the entire thickness of the aquifer and thus receives water by horizontal flow.

B.2.3 Aquifer Test Methods

B.2.3.1 Step-Drawdown Tests

A 6-hour step-drawdown test shall be performed at each of the three initial extraction wells to determine specific capacity and optimal pumping rates. The step- drawdown tests will consist of three steps at variable pumping rates.

B.2.3.2 Constant Discharge Aquifer Test

A 24-hour constant discharge aquifer-pumping test shall be used to determine the hydraulic properties of the aquifer at one specific extraction well location(s). This type of test typically involves monitoring the induced groundwater drawdown in several observation wells or piezometers during continuous pumping of the extraction well(s). Longer-term, constant discharge aquifer pumping tests are the most accurate means of evaluating aquifer hydraulic properties of unconfined systems. Additionally, well performance characteristics such as well capacity, well yield, and well efficiency may be determined using a constant discharge aquifer pumping test.

An aquifer recovery test shall be performed to monitor the residual drawdown following the pumping test. An aquifer recovery test provides additional data for calculating aquifer hydraulic properties and allows for an independent check of the pumping test drawdown results. The aquifer recovery test can also be used to evaluate potential borehole storage effects of the pumping well if the pumping test is performed without the use of piezometers or observation

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wells. Furthermore, recovery data are typically more reliable than drawdown measured during pumping due to the difficulties of maintaining constant discharge from a pumping well.

B.2.3.3 Hydraulic Containment Test

A 72-hour hydraulic containment test shall be conducted while pumping groundwater from the three initial Phase I extraction wells. The purpose of this test is to lower the upgradient water table elevations to a level equal or lower than downgradient elevations in order to achieve hydraulic containment. Each of the extraction wells will be tested simultaneously at pumping rates determined from previous 24-hour constant rate aquifer test.

B.2.4 Equipment Requirements and Definitions

B.2.4.1 Electric Submersible Pump

The submersible pump must be capable of pumping for extended periods of time at a constant discharge rate and must be powered by a reliable source. The discharge pipe or hose shall be equipped with a flow adjustment valve used to regulate flow, which is much more desirable than changing the speed of the pump motor because it allows for better control of the discharge rate.

B2.4.2 Flow Gauge

An in-line flow meter shall be used to measure flow from the extraction pump. The discharge rate will be monitored directly on a meter displaying a constant gallons per minute (gpm) reading and also will be calculated by dividing the quantifiable volume of groundwater collected (at various points during the test) by the time required.

B.2.4.3 Electronic Water-Level Indicator

Manual water-level measurements shall be collected using electronic water-level indicators capable of measuring to 0.01-foot accuracy during all segments of the aquifer test. Electronic water-level indicators will be dedicated to specific wells during the test to avoid errors due to slight differences between indicators. Manual water-level measurements shall be collected as a back-up to water-levels measured using pressure transducers and data loggers. All manual water-level measurements shall be recorded on an aquifer test data sheet, an example of these data collection sheets are included as Figures B-1 and B-2.

B.2.4.4 Pressure Transducer

Pressure transducers shall be used to monitor water levels in pumping wells during aquifer testing. The pressure transducer installed in the pumping well shall be located in the associated piezometer and placed above the level of the pump, but below the anticipated drawdown level. Pressure transducers installed in piezometers shall be placed within the screened interval. The pressure transducers shall be connected to a programmable surface data logger (described

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below). Transducers are available in different pressure ranges. A pressure transducer shall never be lowered to a depth that produces a greater pressure than the operating range of the transducer. Operating ranges in feet of water for different pressure transducers can be determined by multiplying the pounds per square inch (psi) of the transducer by 2.3. For example, a 10-psi transducer can operate from water table to a maximum depth of 23 feet; a 50-psi transducer can operate down to 115 feet below the water table.

B.2.4.5 Data Logger

A data logger is a small field computer capable of recording a wide range of physical measurements such as pressures, temperatures, specific conductance, and flow. The data logger converts the pressure value sent by the transducer into feet of water above the transducer, and records the values in its memory. The data can then be downloaded from the logger to a PC computer. Each transducer has specific parameters that must be input to the data logger to make the appropriate conversions from pressure units to feet of water.

B.2.4.6 Timing Device

All project team members shall have an accurate timer, wristwatch, or stop watch. All timing devices must be synchronized prior to starting any aquifer pumping test. The importance of accurate time measurements cannot be overstated.

B.2.4.7 Health and Safety Equipment

The FMC Site-Wide Health and Safety Plan (FMC, 2012) shall be followed throughout each aquifer tests and any questions not addressed by the plan shall be directed to the Contractor's Corporate Health and Safety Officer or their appointed agent.

B.2.5 Personnel Requirements

Initially, the aquifer pumping tests shall require a minimum of three people at start up. One person shall be responsible for monitoring the flow gauge and adjusting the discharge rate of the pump. One person shall be responsible for starting the data loggers and ensuring that the data loggers continue operating. All team members shall be responsible for taking manual (back-up) water-level measurements with electronic water-level indicators. As the water levels reach a pseudo-steady state, fewer team members shall be required.

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B.2.6 Responsibilities

B.2.6.1 RD Project Manager

The Project Manager shall select the aquifer testing methods with assistance from the project team. The Project Manager is responsible for the preparation of groundwater pumping subcontracts and for regulatory interaction, appropriate permitting, and potential treatment of contaminated groundwater generated during aquifer testing in areas with contaminated groundwater. Additionally, the Project Manager coordinates the project team and ensures access to necessary staffing and equipment resources. For the purpose of these aquifer tests, Rob Hartman (MWH) is the Project Manager.

B.2.6.2 Project Hydrogeologist

The Project Hydrogeologist is responsible for the successful completion of the testing program in a technically sound manner. The Project Hydrogeologist is responsible for the design of the testing methods, data acquisition methods, and data analysis. The Project Hydrogeologist must have thorough understanding of the site hydrogeology to the extent known and must be have knowledge and extensive experience using field instruments and equipment, such as pressure transducers, data loggers, pumps, flow gauges, and meters. The Project Hydrologeologist must possess knowledge in the areas of well hydraulics and aquifer mechanics and is responsible for data reduction and analysis. The MWH Project Hydrogeologist for these aquifer tests shall be Jesse Stewart.

B.2.6.3 Field Team Leader

The Field Team Leader coordinates logistical aspects of the testing program and is responsible for accurate and precise data collection by all field team members. The Field Team Leader assists in the design of the aquifer testing program and must have working knowledge of equipment and instruments used in testing methods implemented. William Bragdon shall serve as the MWH Field Team Leader.

B.2.6.4 Project Staff

Project Staff assist in data acquisition and data reduction and in the design of the aquifer testing method and with data analysis. Project staff shall be chosen from a pool of qualified hydrogeologists and field technicians, based on program schedule. At least one member of the Project Staff will be on-site at all times during aquifer testing.

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B.3 TEST DESIGN CONSIDERATIONS

The following design components must be evaluated prior to initiation of a pumping test:

- **Extraction wells.** Each of the extraction wells will be designed as part of the Hydrogeologic Study for pumping and must be fully developed and capable of sustained and prolonged pumping. The first three Phase I extraction wells will be located in northeast portion of the Former Operations Area as per Figure 1-3). Nearby observation wells or piezometers are required for distance-drawdown calculations (see Figure 1-3).

- **Choice of piezometers.** Ideally, water levels shall be monitored in as many nearby monitoring wells or piezometers as feasible. Prior to conducting the pumping test, zones of influence may be estimated using well-flow equations to determine which wells likely will show a drawdown response. It is beneficial to use monitoring wells and piezometers located upgradient, downgradient, and cross-gradient from the pumping well to evaluate hydraulic anisotropy and or heterogeneities.

- **Step Tests.** A 6-hour variable rate step-drawdown test shall be performed in each of the three extraction wells to calculate specific capacity and determine the pumping rate for the constant rate test. Step tests will also be performed in any additional extraction wells installed (up to two additional wells) to determine well specific capacity and substantial pumping rates.

- **Constant Discharge Aquifer Test.** A 24-hour constant discharge aquifer test will be performed in the western-most extraction well. This test will be used to determine the hydraulic properties of the aquifer at a single pumping/extraction well location. This type of test typically involves monitoring drawdown in several observation wells and/or piezometers. Long-term, constant discharge aquifer pumping tests are the most accurate means of evaluating aquifer hydraulic properties of unconfined systems. In addition, well performance characteristics such as well capacity, well yield, and well efficiency may be determined using a constant discharge aquifer pumping test.

- **Hydraulic Containment Test.** Once the first three extraction wells are in place and the variable rate step-drawdown and constant rate tests are completed, a hydraulic containment test shall be performed. Each of the extraction wells will be tested simultaneously at pumping rates determined from previous aquifer tests. Pumping rates may need to be varied or tuned during the test due to superposition of drawdown between extraction wells. Water level measurements will be measured in extraction wells, monitoring wells and piezometers. The objective of this test is to lower the

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upgradient water table elevations to a level equal or lower than downgradient elevations in order to achieve hydraulic containment.

- **Duration of Pumping Test - Unconfined Aquifer.** The cone of depression that results from pumping expands much more slowly for unconfined aquifers than for confined aquifers. The generally accepted minimum duration pumping test for an unconfined aquifer is 72 hours. However, the initial constant rate pump test will be performed for 24 hours to primarily establish well yields to be expected during the final 72-hour hydraulic containment pump test.

- **Size of pump.** The size of the pump shall be based on the drawdown requirements and estimated specific capacity of the well. Pumping rates will be determined from evaluation step drawdown tests that will be performed prior to the constant discharge aquifer pumping tests to determine the flow rates from the constant rate tests and the specific capacity.

- **Discharge Rate.** The discharge rate shall be based on the results of a step-drawdown and initial 24-hour constant rate testing program. The specific capacity calculated from the step-drawdown and constant rate tests shall be used to estimate the desired drawdown and pumping rate. Because of the uncertainty in the step test calculations, a level of safety shall be factored into the desired drawdown level to ensure that the water level is not drawn down to the pump. If the water level is lowered to the pump, pumping shall be terminated immediately and collection of recovery data shall be started until the aquifer recovers to static conditions.

- **Pre-Test Water Level Measurements.** One barometric pressure transducer shall be installed in the pumping well, and transducers shall be set into observation wells at least two days prior to the start of pumping to monitor pre-test trends and to correlate changes in water levels to changes in barometric pressure. Measurements shall be recorded every hour with a linear scale set on the data logger.

- **Pumping Test Water Level Measurements.** Water-level measurements during the test shall be collected at various frequencies. Individual water-level indicators can be dedicated to monitoring wells and piezometers. Pressure transducers with data loggers shall be installed in extraction well piezometers and up to ten additional piezometers (i.e., PZ01- PZ-06) and monitoring wells (see Table 3-1) within the anticipated zone of influence. Manual water-level measurements during the constant discharge aquifer pumping test shall be collected at various frequencies depending on the proximity of the monitoring wells and piezometers to the pumping well. Table B-1 lists a suggested measurement frequency schedule that can be followed during constant discharge aquifer pumping tests. The measurement frequency schedule presented in Table B-1 is a suggested frequency and may need to be modified to meet

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specific needs for individual monitoring wells and piezometers. Water-levels measured electronically using pressure transducers and data loggers shall be collected using the logarithmic time interval cycle shown in Table B-2. The logarithmic time interval allows for extremely rapid measurements during the initial portion of the test and then gradually slows the measurement frequency during later segments of the test. Table 3-1 provides a list of all piezometers and wells to be measured during the various pump tests.

- **Aquifer Recovery Test Water Level Measurements.** Water levels shall be measured during the recovery portion of the constant-rate test according to the same schedule as the pumping portion of the test (see Tables B-1 and B-2). That is, water levels shall be collected more frequently immediately after the pump is shut off and less frequently in the later stages of the recovery. The data loggers shall be reset to collect water-level recovery data, using a logarithmic interval. The recovery portion of the constant-rate test often provides some of the best data because, when the pump is shut off, water levels recover without the influence of well loss, erratic pumping, or turbulent flow near the pumping well provided that the check valve in the well functions properly.

- **Collection of Water Samples**. Groundwater samples will be collected as described in Section 3.0 of the Plan and documented on the water sampling form provided in Appendix C.

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TABLE B-1

**SUGGESTED MANUAL MEASUREMENT FREQUENCY
USING CALIBRATED ELECTRONIC WATER-LEVEL INDICATORS
FMC OU, POCATELLO, IDAHO**

ELAPSED TIME	MEASUREMENT FREQUENCY
0-20 minutes	30 seconds
20-40minutes	2 minute
40-60 minutes	5 minutes
60-120 minutes	10 minutes
2-12 hours	1 hour
12 hours to 3 days	2 hours

TABLE B-2

**TIME INTERVAL SCHEDULE
FOR PRESSURE TRANSDUCERS AND DATA LOGGERS
FMC OU, POCATELLO, IDAHO**

LINEAR CYCLE	MEASUREMENT INTERVAL	TOTAL DATA POINTS PER CYCLE
30 minutes	1 second	1800
30 minutes – 6 hours	10 second	1980
6 hours -72 hours	10 minute	396

- **Discharge Water.** The discharge water from the pumping tests will be collected in portable water containers for appropriate management per SOP 4 (Appendix D).

- **Miscellaneous.** Precipitation events must be recorded in the field notes, including time of onset, and duration. Barometric readings shall be measured by a barometric transducer and data logger. The barometric transducer shall be suspended in the

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pumping well to minimize diurnal variations due to temperature changes. Barometric pressure effects on water levels shall be evaluated during the constant-rate test and factored into the analysis if necessary. For shallow zone wells, the passing of heavy equipment or trains shall be noted on the field logs.

B.4 AQUIFER TESTING PROCEDURES

B.4.0.1. As described in Section B.1, several piezometers will be monitored during the step-drawdown tests, the 24-hour constant rate-pumping test, and the 72-hour hydraulic containment test to determine aquifer characteristics. For each test, Table B-3 outlines the specific design parameters for each test for the pumping wells, piezometers, control point wells, water level measurements and frequency, and collection of water samples. Table B-3 also provides recommendations for the pump size, discharge rate, discharge water/industial-derived waste (IDW), traffic control, and other miscellaneous items that may influence or need to be considered during the test.

TABLE B-3

SITE-SPECIFIC CHARACTERISTICS AND DESIGN CONSIDERATIONS
FMC OU, POCATELLO, IDAHO

Design Parameter	Step-Drawdown and Constant Rate Extraction Well Test	72-Hour Hydraulic Containment Test
Extraction Wells	Each extraction well will be screened over the entire saturated thickness (from the water table to the top of the low permeability unit). It is anticipated that the extraction wells will be screened from approximately 120 to 150 feet bgs. The casing and screen will be 6" in diameter with 20-slot screen and a sand filter pack size selected based on field conditions.	Each extraction well will be operated simultaneously at the optimal flow rate determined during step-drawdown tests and the constant rate test.
Observation Points Distant Wells	Each extraction well will be paired with piezometers as detailed in the Plan. The extraction wells and specific piezometers will be monitored using pressure transducers. The monitoring wells listed in Table 3-1 will be used as distant wells during the test, and specific up- and downgradient monitoring wells installed for the system. Data from these wells will be used to determine the extent of drawdown only.	At a minimum, piezometers both up- and downgradient of each extraction well will be monitored to determine water table elevation. Piezometers shall be measured manually using electronic water level indicators. However, the same water level indicator shall be used in piezometer pairs so measurement can be correlated. Additionally, each water level indicator used for the test shall be calibrated against a "master tape." This is completed by measuring three different depths to water in different wells with each tape followed by creating a linear regression for each indicator for determining a correction to apply. The monitoring wells listed in Table 3-1 will be used as distant wells during the test and specific up- and downgradient monitoring wells installed for the system. Water levels in these wells will be recorded manually only. Data from these wells will be used to determine the extent of drawdown only.
Control Point Wells	Well 165 will be designated as the control point well. No drawdown is anticipated at this location during individual well tests. Manual water levels will be collected daily at this well.	Well 165 will be designated as the control point well. No drawdown is anticipated at this location during individual well tests. Manual water levels will be collected daily at this well.
Size Of Pump	A submersible pump shall be used during the test. The pump size will be based on development. A pump controller shall be used to vary the speed and pumping rate of the pump. A throttling valve on the discharge line of the pump shall be used to provide additional flow control.	Dedicated pumps will be used for the test. Pump size for individual wells will be based on results of step-drawdown tests and the constant rate test.
Duration Of Test	Since this test assumes an unconfined aquifer, the constant rate test will last for a total of 24 hours, plus a step drawdown test that shall consist of three steps lasting for approximately 2 hours each. The steps shall be performed at approximately 75, 95, and 115 gpm, but may be greater or lower depending on the well capability (development of the well will assist in determining pumping capability). After the step test has been completed, the system shall be allowed to equilibrate at least overnight, prior to commencing the constant rate aquifer-pumping test.	Since this test assumes an unconfined aquifer, the test shall last for a minimum of 72 hours. Total test duration may be much longer in order to achieve hydraulic containment.
Discharge Rate	This shall be based on the results of the step-drawdown test that will be conducted prior to beginning the aquifer-pumping test. Currently, it is estimated that approximately 90 to 120 gpm of water shall be produced from each extraction well for the duration of the test based on preliminary modeling.	Discharge rates shall be based on the results of the individual extraction well constant rate aquifer tests

TABLE B-3

SITE-SPECIFIC CHARACTERISTICS AND DESIGN CONSIDERATIONS
FMC OU, POCATELLO, IDAHO
(continued)

Design Parameter	Step-Drawdown and Constant Rate Extraction Well Test	72-Hour Hydraulic Containment Test
Pumping Test Water Level Measurements And Frequency	Measurements shall be made using the temporary pressure transducers and dataloggers at frequencies outlined in Table B-2. Backup measurements shall be made using an electronic water-level indicator at frequencies outlined in Table B-1.	Measurements will be made at each of piezometers prior to the test, 10 minutes after start-up, and then hourly for the next 8 hours using an electronic water-level indicator. After 8 hours, water level will be collected on a frequency of every four hours until the end of the test. One measurement will be completed prior to shut down. Measurements will also be made using dedicated pressure transducers in the extraction wells and piezometers, if available.
Aquifer Recovery Test Water Level Measurements	Measurements shall be made using the temporary pressure transducers and dataloggers at frequencies outlined in Table B-2. Backup measurements will also be made using an electronic water-level indicator at frequencies outlined in Table B-1.	A recovery test will not be performed for the hydraulic containment test.
Collection Of Water Samples	Water samples shall be collected from the extraction wells as described in Section 3.5.2 of the Plan. Samples will be sent to the laboratory and analyzed for as provided in Table 3-2. Field parameters will also be monitored when analytical samples are collected.	Water samples shall be collected from the extraction wells as described in Section 3.0 of the Plan and documented on the water sampling form provided in Appendix C. Samples will be sent to the laboratory and analyzed as provided in Table 3-2. Field parameters will also be monitored when analytical samples are collected.
Discharge Water	Discharge water shall be collected tank(s). Discharge water shall be managed per SOP 4 (Appendix D).	Discharge water shall be collected tank(s). Discharge water shall be managed per SOP 4 (Appendix D).
Traffic Control	None anticipated for this test	None anticipated for this test
Miscellaneous	All meteorological parameters and physical disturbances that could impact the results of the test shall be noted in the field logbook. A pressure transducer for reading barometric fluctuations will be installed in the extraction well during the test.	All meteorological parameters and physical disturbances that could impact the results of the test shall be noted in the field logbook. A pressure transducer for reading barometric fluctuations will be installed in the production well during the test.
	A diesel-fueled portable generator will be used to supply power to all field equipment.	A permanent power supply shall be in place. However if permanent power supply is not available, a portable diesel-fueled generator will be used.

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B.4.1 STEP-DRAWDOWN TEST PROCEDURES

B.4.1.1. Continuous data logging equipment shall be used wherever possible, although manual backup measurements shall also be collected as discussed above. All of the data loggers shall be synchronized to the correct day, date, and time. All project team members must synchronize their watches to the correct time datum.

1. Remove the well head expansion cap from all observation wells and piezometers, as well as the extraction well/associated piezometer. Allow all wells to equilibrate to atmospheric conditions.

2. Record the static water level in all test wells using electronic water-level indicators.

3. The pump shall be set in the well at the desired pumping level, usually within the screened interval. Contaminated groundwater discharged from the well may require storage in portable tanks or require treatment prior to disposal. All disposal options and permitting must be in place prior to conducting the test.

4. Determine the appropriate depth of the transducer for the pumping well. The transducer shall be placed at least 3 to 5 feet above the pump if possible to minimize interference with the pump. In some instances, installation of the transducer below the pump may be required. Lower the transducer to the target depth in the pumping well piezometer. Allow the well to equilibrate to static water levels.

5. Install pressure transducers in all of the selected observation wells/piezometers included in the test well in a manner similar to that described above. In typical applications, a 10-psi transducer (highly accurate up to 23 feet below the water table) is adequate for monitoring drawdown in observation wells. Secure transducer cables above ground surface and affix duct tape to each cable to monitor if any slippage occurs.

6. Connect the pressure transducers to the data logger. Enter the required transducers parameters and other test parameters in the data logger and record transducer input parameters on the transducer form shown in Figures B1 and B2. The data logger typically prompts the user to record water levels below the top of casing (TOC) or surface. Surface refers to a static water level datum. The instrument is therefore "referenced" or "zeroed" to either a static water level or to a value input by the operator. Water levels below static water level shall be recorded as negative values. For pumping test purposes, water levels can be recorded relative to either "TOC" or "surface". Note that referencing to "surface mode" minimizes mistakes in the field. An accurate record of all input parameters and field observations must be included in a field log.

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7. "Zero" the pressure transducer/data logger to static water levels (or, alternatively, enter the TOC value for each well). Confirm static levels (or TOC-adjusted values) with an electronic water-level indicator.

8. For the pumping well and for observation wells close by the pumping well, it shall be advantageous to record the early time data at very frequent intervals. This is best accomplished using the logarithmic data-recording mode shown in Table B-2, where each transducer is pre-set to start when the pump is started.

9. *TEST START-UP* — This is the critical step. Once the pump is started, there is no going back. At a pre-determined time, one person must simultaneously start the pump and quickly stabilize the discharge rate to the discharge rate of the first “step”. Set the logger to the "delayed start mode" to begin at a pre-determined time. Ideally the logger will begin recording one second before pumping begins. Other project team members must begin manually measuring and recording water levels on a pre-determined frequency (see Table B-1). The data recorded by the transducers and data logger can be viewed following completion of the logarithmic data recording cycle (after 10 minutes). Water-levels measured by the transducers shall be similar to the manually measured water levels. After running the test for exactly 2 hours, the discharge rate is quickly “stepped up” to a higher pumping rate, and the frequency of water level measurements are collected at a frequency comparable to that required at the start of a new test. After running the test for exactly 2 hours, the discharge rate is again quickly “stepped up” and the process is repeated.

B.4.2 CONSTANT RATE PUMPING TEST PROCEDURES

B.4.2.1. After completing the step-drawdown tests, the site shall be allowed to recover at least overnight so that equilibrium conditions can be re-attained. During this time, the data from the step test shall be evaluated and the ideal pumping rate for the test will calculated. The following procedure shall then be used to conduct the aquifer pump test:

1. Procedures 1-8 of the step test shall be followed prior to commencing the aquifer pumping test.

2. *TEST START-UP* — This is the critical step. Once the pump is started, there is no going back. At a pre-determined time, one person must simultaneously start the pump and quickly stabilize the discharge rate to the desired discharge rate (determined from a step test, slug tests, or previous aquifer tests). Set the logger to the "delayed start mode" to begin at a pre-determined time. Ideally the logger will begin recording one second before pumping begins. Other project team members must begin manually measuring and recording water levels on a pre-determined frequency (see Table B-1). The data recorded by the transducers and data logger can be viewed following completion of the logarithmic data recording cycle (after 10 minutes). Water-levels measured by the

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transducers shall be similar to the manually measured water levels. It is always beneficial to plot the time and drawdown data in the field to ensure that the pumping rate and the drawdowns are adequate.

B.4.3 Aquifer Recovery Tests

B.4.3.1. An aquifer recovery test shall always be completed following a constant rate pumping test. As stated above, recovery data are often more reliable than drawdown data due to difficulties of maintaining an absolute constant discharge rate from a pump.

1. Complete a constant discharge aquifer pumping test in the manner detailed above.

2. Wait for data logger to record a point (every 200 minutes at this time), then complete a round of water levels.

3. At a pre-determined time (a minimum of 72 hours after pumping begins), simultaneously turn off the pump, and restart the data loggers to measure aquifer recovery using the logarithmic data recording mode (Table B-2). Stop the pump immediately (one second) after restarting the data logger. Manual measurements shall be collected using electronic water-level indicator using the suggested frequency presented in Table B-1. Continue recording the recovery data until the water levels return to static (or at least 90 percent of original static levels). At this time the test is completed.

4. Carefully download the field data from the transducers to a computer. Obtain a hard copy and a master electronic copy to be stored inviolate.

B.4.4 HYDRAULIC CONTAINMENT TEST PROCEDURES

B.4.4.1. Once the constant rate aquifer test has been completed and the wells have returned to static conditions, a hydraulic containment test will be performed. For this test, each of the extraction wells shall be started simultaneously at the optimal pumping rate determined during the constant rate aquifer test. The objective of this test is to determine whether hydraulic containment is being achieved. Therefore, water levels will be collected from the entire extraction well system and associated observation wells, but are not time critical like a constant rate aquifer test. Hydraulic containment will be achieved when upgradient water table elevation is equal or less than downgradient water table elevation. Additionally, pumping rates in wells may need to be adjusted due to super position of drawdown between extraction wells. Water levels in extraction wells will need to be monitored closely so that maximum drawdown will not exceed pump levels. The hydraulic containment test shall be operated for a minimum of 72 hours to determine long-term effects of the extraction system. Specific measurement times are presented in Table B-1 and B-2.

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B.6 REFERENCES

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Figure B-1
AQUIFER TEST DATA SHEET
(PUMPING WELL)

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PROJECT NAME: ____________ PROJECT NO: ____________ WELL NO: ____________
DATE: ____________ PUMP DEPTH: ____________ TEST NO: ____________
TYPE OF TEST: ____________ PUMPED WELL NO: ____________ DISTANCE FROM PUMPING WELL: ____________
MEASURING EQUIPMENT: ____________ HYDROGEOLOGIST: ____________

Time Data	Water Level Data	Water Quality	
Pump On: Date/Time__________(t) Pump Off: Date/Time__________(t') Duration of Aquifer Test: Pumping:__________ Recovery:_________	Pretest Water Level___________________ Static Water Level:___________________ Measuring Point:_____________________ Elevation of Measuring Point:___________		

Date	Time Since Pump Started t (min)	Time Since Pump Stopped t' (min)	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)	pH	Specific Conductivity	Temperature	Comments on factors affecting test data

Conversion Factors: 1 PSI = 2.31 feet **1 cubic foot = 7.48 gallons**

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Figure B-2

AQUIFER TEST DATA SHEET
(OBSERVATION WELLS)

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PROJECT NAME: ______________ PROJECT NO: ______________ PIEZO NO: ______________

DATE: ______________ PUMP DEPTH: ______________ TEST NO: ______________

TYPE OF TEST: ______________ PUMPED WELL NO: ______________ DISTANCE FROM PUMPING WELL: ______________

MEASURING EQUIPMENT: ______________ HYDROGEOLOGIST: ______________

Time Data Pump On: Date/Time_________ Pump Off: Date/Time_________ Duration of Aquifer Test: Pumping:_________ Recovery:________		**Water Level Data** Pretest Water Level________________ Static Water Level:________________ Measuring Point:__________________ Elevation of Measuring Point:__________			**Time Data Continuation**		**Water Level Data Continuation**		
Date	Time	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)	Date	Time	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)

Conversion Factors: 1 PSI = 2.31 feet 1 cubic foot = 7.48 gallons

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APPENDIX C

Groundwater Sampling Field Form

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GROUND-WATER/SURFACE WATER SAMPLING LOG

Project No: ____________ Sample Location ____________ Surface Water ☐ Ground Water ☐

Sampling Personnel____________ Date____________ Start Time ____________ Weather____________

Depth to Water____________ Depth to Product ________ Product Thickness ________ Measuring Point ____________

Borehole Dia. ____________ Calculated Purge Volume ________ Gallons Total Casing Depth/Dia. __________

Sampling Method: Dedicated Submersible Pump ☐ Portable Submersible Pump ☐

Dedicated Bladder Pump ☐ Portable Bladder Pump ☐ Surge/Bail ☐ Surge Block Type ______

Disposable Bailer ☐ Bailer Type ____________

Pump Started ________ Pump Stopped ________ Total Gallons _______ Organic Vapor at Well Head ________

Time (military)	pH	SC (umhos/cm)	Temp (°C)	Eh-ORP (millvolts)	D.O. (mg/L)	Turbidity (NTU)	Vol Evac. (gal.)	Comments/ Flow rate

Final:

Time	pH	SC	Temp	Eh-ORP	D.O.	Turbidity	Ferrous Iron	Vol Evac.	Comments/Flow rate

COMMENTS: ____

HYDROLAB: pH Calibration Buffers: 4 ☐ 7 ☐ 10 ☐ Eh Reference Solution ____________

SC Reference Solution ______ umhos/cm Turbidity Reference Solution ________ NTUs

Sample Name ____________ TIME ____________ VOCs ☐ Sulfide ☐ Anions/Alkalinity/TDS ☐

TOC ☐ Cations ☐ Trace Metals ☐ SVOCs ☐ Perchlorate ☐ Explosive ☐ TPH Gas ☐ Dioxin/Furans ☐

TPH Diesel/Motor Oil ☐ ____________ ☐ ____________ ☐ ____________ ☐ ____________ ☐

MS/MSD ____________ BD____________ BD Name/TIme ____________ TB ____________

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APPENDIX D

Standard Operating Procedures

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

This SOP has been revised from SOP No. 1 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

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1.0 INTRODUCTION

This standard operating procedure (SOP) defines minimum requirements that shall be fulfilled by all personnel in order to obtain site access and clearance(s) necessary to perform assigned tasks at FMC. It is the Contractor's responsibility to determine necessary clearances. Access and clearances required may include, but are not limited to, the following:

- Site access and clearance: FMC Project Manager
- Digging, Drilling, Excavation: FMC and/or FMC's contractor for FMC-owned property and Idaho Dig Line for off property locations (not anticipated).
- Public Road Closure: Idaho Department of Transportation
- Union Pacific Railroad where digging, drilling, or excavations are near the active Union Pacific Railroad tracks.

Close attention shall be paid to minimum waiting periods required before certain authorizations and clearances can be issued. Proper documentation shall be maintained at all times as evidence that authorization/clearance has been obtained. The minimum requirements for the above list are specified in this SOP. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

2.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved as needed. Project team member information shall be

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included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible for ensuring all personnel, including sub-contractors, have the applicable authorization(s) and clearance necessary to perform tasks as assigned. The RDRA Project Manager shall coordinate with other key project staff and FMC personnel to accomplish this task.

Field Team Leader (FTL): Responsible for ensuring access requirements are observed by field personnel at all times, preparing daily logs of field activities, and ensuring that documentation of all appropriate authorization(s) and clearance are at the work site at all times.

Field Technician (or other designated personnel): Assists the FTL with the implementation of field tasks.

3.0 ACCESS TO FMC-OWNED PROPERTY

The entrances to the FMC-owned property will normally be locked at all times. Entry onto the Site will be performed in accordance with the FMC Site-Wide Health and Safety Plan Section 5.1. RDRA contractors and subcontractors will have access to the gate key or code based upon approval and coordination with the RDRA Field Team Leader (FTL) and/or the RDRA Project Manager. All other contractors and/or visitors must obtain approval from FMC and schedule arrival and departure dates/time with FMC at the FMC Pocatello office.

All RDRA contractor and subcontractor employees performing work at the FMC Plant OU will be required to check in and check out with the FTL through the use of a sign-in sheet. A daily field log and sign in sheet will be kept at the work site by the FTL that will

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document all on site personnel and visitors. Persons not meeting the minimum standards as defined in SWHASP will not be allowed access by the FTL.

4.0 HOT WORK CLEARANCE

All cutting, welding, brazing, and other hot work will comply with all safety requirements of FMC SWHASP and the Safety, Fire Prevention and Health (AFOSH) Standard 91-5, OSHA 1910.252, and the National Fire Protection Agency (NFPA) codes.

Under this standard, personnel or contractors involved in RDRA activities that require welding, cutting, brazing, or other “hot work” shall fulfill the following requirements:

1. The RDRA contractor shall contact the FMC and the FTL prior to performing any hot work. This will allow the appropriate review and inspection of the work area prior to cutting, welding, brazing, or other “hot work”. As the FMC Plant OU is expected to be fully decommissioned at the time of the RDRA field work, each case will be reviewed for potential hazards or other safety concerns. After such review, written approval (e.g., documented in the site log book) must be obtained from the FTL prior to any RDRA contractor performing hot work on the site.
2. Provide adequate number of portable fire extinguishers and place them as close to the work area as possible.

5.0 UTILITY CLEARANCE ON FMC-OWNED PROPERTY

Underground and aboveground utility clearance will be completed before subsurface investigations commence on FMC-owned property (including obtaining an excavation permit consistent with the requirements of Section 3.2.8 of the SWHASP) or off property (see Section 6 and 7 for requirements pertaining to investigations on lands not owned by FMC). The area within a 5-foot radius of each subsurface sampling location will be cleared using the following protocol:

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1. Review available facility utility maps provided by FMC and/or FMC's contractor, A&E Engineering.
2. Mark the proposed sampling locations and the utility lines in the immediate vicinity using a marker, stake, flags, or paint.
3. Verify proposed sampling locations with FMC plant or A&E employees with knowledge of the utilities to discuss undocumented utilities, potential obstructions, etc.
4. Scan the surface with a magnetic locator according to the manufacturer's directions to search for the presence of buried utilities and other obstructions.
5. Hand auger or push a probe to a depth of 4 to 5 feet below ground surface in areas where historic maps or historic knowledge of subsurface utilities are not available.
6. Overhead telephone and power lines shall also be taken into account when selecting drilling/excavation locations.
7. The RDRA contractor shall notify FMC and A&E in case of any suspicion or confirmation of damage to any underground utilities.

6.0 UTILITY CLEARANCE ON LANDS NOT OWNED BY FMC

Although subsurface investigation is not expected off FMC-owned property as part of the scope of this RDRA, the Idaho Dig Line provides one central location for contractors and the general public to call and notify multiple utility companies of intended excavation (off FMC-owned property). Information, contractor responsibilities, and an online tool to notify Idaho Dig Line of planned work can be found by calling 800-342-1585. Idaho Dig Line shall be notified at least 48 hours, but no more than seven (7) days, prior to drilling or excavation. Notices of drilling or excavation are good for 14 calendar days. Requests for a utility meeting with locators are scheduled through the Idaho Dig Line. If drilling or excavation on a single project lasts more than 14 days, Idaho Dig Line shall be notified prior to the deadline to update clearance permits. To obtain clearance for any drilling or excavation off FMC-owned property, MWH and/or its RDRA subcontractor shall provide Idaho Dig Line with the following information:

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- Company information including company name, address, and telephone number
- The name and telephone number of the caller
- Type of work to be accomplished including information regarding anticipated depth and information regarding horizontal or vertical boring
- Date of proposed work
- Precise location of the proposed drilling/excavation site. This shall be a detailed description including street address, street names and numbers, subdivision lot number if available, direction and distance relative to street or intersection (north, south, east, or west), and any other relevant information. If possible, the site shall be pre-marked with white paint, stakes, or flags
- Provide a location map if requested by Idaho Dig Line
- Marking instructions (e.g., portion of site to be cleared by Idaho Dig Line)
- Field personnel contact name and telephone number

If subsurface investigation is required off FMC-owned property, the RDRA contractor/excavator shall work with MWH to provide this information. MWH shall obtain a Location Request Number from the Idaho Dig Line representative. This is a number that references the caller with the details of the proposed excavation and is helpful when contacting a member utility or Idaho Dig Line for further assistance. MWH and the RDRA subcontractor shall possess this number at all times on job sites to prove compliance with state statutes.

After Idaho Dig Line and local utilities have marked the proposed drilling or excavation site, a minimum clearance of five feet will be maintained between a marked and unexposed underground facility and the cutting edge or point of any power-operated excavating or earth moving equipment. If excavation is required within five feet of any marking, the excavation shall be performed utilizing a hand auger or probe point to check for underground utilities. MWH or the subcontractor shall notify FMC and the Idaho Dig Line in case of any suspicion or confirmation of damage to the underground utilities.

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Underground utilities are marked with paint or pin flags with a color scheme representing different utilities. The way that these lines will be identified by the various utilities are defined by the following legend:

Red = Electric

Yellow = Oil and Gas

Orange = Communications including Cable TV, telephone and fiber optics.

Blue = Water

Green = Sewer

Pink = Temporary Survey Markings

White = Proposed Excavation

7.0 PUBLIC ROAD CLOSURE

Although not expected as part of the scope of this RDRA, the Idaho Department of Transportation (IDOT) requires road/lane closures for all work conducted on designated highways, or shoulder areas of designated highways, within the state of Idaho. This includes, but is not limited to, drilling and excavation and other work to be performed along roadways and shoulders. In such a case, it is the responsibility of MWH to contact IDOT for any authorizations. The following information must be submitted with the application:

- Applicant’s name, address and phone
- Reason for permit
- Location of work site, including highway number, city, county, milepost or description
- Anticipated commencement and completion of construction/work
- Instructions for new utility installations
- A map of the work area if possible
- A diagram of the type of road closure signs required
- A name and address of the personnel who will close the lane/road

A performance bond may be required by IDOT prior to commencement of work on IDOT property.

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STANDARD OPERATING PROCEDURE 2

EQUIPMENT DECONTAMINATION

This SOP has been revised from SOP No. 3 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURES 3

EQUIPMENT DECONTAMINATION

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1.0 INTRODUCTION

Decontamination of drilling, sampling equipment, monitoring/inspection equipment and support vehicles at the FMC site is a necessary and critical aspect of environmental field investigations. Proper decontamination is a key element in reducing the potential for cross-contamination between samples from different locations, ensuring that samples are representative of the sampled materials, as well as health and safety issues associated with elemental phosphorus. Improper decontamination may result in costly re-collection and re-analysis of samples. All equipment used in the sampling process shall be properly decontaminated prior to the collection of each sample and after completion of sampling activities.

The procedures outlined in this standard operating procedure (SOP) shall be followed during decontamination of field equipment used in the sampling process, including drilling, soil/water sample collection, and monitoring/inspection activities. Any deviations from these procedures shall be noted in the field logbooks and approved by the RDRA Project Manager and the Quality Manager. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

Three major categories of field equipment, along with applicable decontamination methods for each, are discussed below.

2.0 DEFINITIONS

Brass Sleeve: Hollow, cylindrical sleeves made of brass and used as liners in split-spoon samplers for collection of undisturbed samples.

Auger Flight: An individual hollow-stem auger section, usually 5 feet in length.

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Continuous Core Barrel: 5-foot long steel barrels that can be joined together to allow continuous cores to be collected during a single run.

Drill Pipe: Hollow metal pipe used for drilling, through which soil and groundwater sampling devices can be advanced for sample collection.

Potable Water: A drilling quality water source that can be used for steam cleaning and decontamination water. This source should be sampled at the beginning of each field program to set baseline concentrations.

Distilled Water: Commercially available or laboratory-grade water that has been distilled. Each batch of distilled water should be analyzed to set baseline concentrations. The distilled water will be used as rinse water during the decontamination of tools, sampling equipment and other small items.

Hand Auger: A sampling tool consisting of a metal tube with two sharpened spiral wings at the tip.

Split-Spoon Sampler: A sampling tool consisting of a thick-walled steel tube with a removable head and drive shoe. The steel tube splits open lengthwise when the head and drive shoe are removed.

Scoop: A sampling hand tool consisting of a small shovel- or trowel-shaped blade.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

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RDRA Project Manager: Selects project-specific drilling and sampling methods, and associated decontamination procedures with input from other key project staff and other personnel that are responsible for project quality control.

Quality Manager: Performs project audits. Ensures project-specific data quality objectives are fulfilled.

Field Team Leader (FTL) and/or Geologist, Hydrogeologist, or Engineer: Implements the field program and supervises other sampling personnel. Ensures that proper decontamination procedures are followed. Prepares daily logs of field activities.

Field Sampling Technician (or other designated personnel): Assists the FTL, geologist, hydrogeologist, or engineer in the implementation of tasks and is responsible for the decontamination of sampling equipment.

4.0 DECONTAMINATION PROCEDURES

A decontamination pad designed to collect the rinsate and any associated soil or chemicals will be established in a location at the FMC site. The decontamination pad will be constructed in an area designated by FMC and will be used for the duration of the field activities. The decontamination pad will be large enough to accommodate the drilling equipment components that come into contact with contaminated soils or groundwater that are present at the site. The rinsate collected from the decontamination pad and from other onsite decontamination activities will be stored in labeled containers until the proper disposal protocol is established pending waste characterization.

Soil boring drilling and soil sampling procedures require that decontaminated tools be employed in order to prevent cross-contamination. The decontamination procedures described below shall be followed to ensure that only uncontaminated materials will be introduced to the subsurface during drilling and sampling. For equipment and tools that have come into contact with contaminated soils or groundwater, the equipment

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decontamination process shall be undertaken before and after each use of the equipment and include washing. The flooring of the decontamination pad shall be impermeable to water and have a sump or low area to collect the rinsate to be transferred into the storage containers.

The precise location of the decontamination facility shall be determined based on such factors as ease of access for personnel and proximity to work site and rinsate storage or staging areas.

4.1 DRILLING AND LARGE EQUIPMENT

4.1.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment and support vehicles in areas of the Site in which there is a potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). This will include percussion hammer drill pipe, hollow-stem auger flights, drill rods for sampling, the drill rig, support vehicles and other equipment and tools that may come in contact with sampling equipment or that may have possible contamination.

- Wash the external surfaces and internal surfaces, as applicable, on equipment using water from an approved water source. If necessary, scrub using a phosphate-free detergent (e.g., Alconox™), or equivalent laboratory-grade detergent until all visible dirt, grime, grease, oil, loose paint, rust, etc., have been removed.
- Rinse with potable water.

4.1.2 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment, trenching equipment, construction equipment, and support

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vehicles in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). Note that this procedure will apply to equipment that comes into contact with native soils and/or slag on slag covered roads or surfaces. For example, trenching in the Western Undeveloped Area and/or construction of the test gamma cap will involve drilling, trenching, digging, or construction activities in areas where the large equipment will only contact native soils and slag on roads and/or construction surfaces.

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing tires and other surfaces that came into contact with native soils or slag.

4.2 SOIL AND GROUNDWATER SAMPLING/INSPECTION EQUIPMENT

4.2.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedure will be used to decontaminate sampling/inspection equipment such as split-spoon samplers; brass sleeves; continuous core barrels; scoops; hand augers; metal sampling pans; video equipment and other sampling/inspection equipment and tools that may come into contact with contaminated soils and/or groundwater.

- Wash and scrub equipment with phosphate-free, laboratory-grade detergent (e.g., Alconox™ or equivalent); steam cleaning may also be performed if possible.
- Double or Triple-rinse with potable water.
- Air dry.
- Store in clean plastic bag or designated casing.

Personnel involved in decontamination activities shall wear appropriate protective clothing as defined in the project-specific health and safety plan.

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4.2.2 In Areas with Potential Contact with Elemental Phosphorus

The following procedure will be used to decontaminate sampling/inspection equipment such video equipment and/or sampling equipment and tools that may come into contact with site materials contaminated with elemental phosphorus (P4). The only activity where potential P4 exposure is expected is while video surveying the storm sewers in RA-A. Special health and safety precautions for the storm sewer video survey include:

- Persons involved in the video survey of the RA-A storm sewers should read and be familiar with the hazards of P4 exposure as presented in Section 3.1.3 of the SWHASP. Note that the immediate area around the location where the storm sewer video survey is being performed shall be designated an *Exclusion Zone* as discussed in Section 6.1.1 of the SWHASP.
- Persons involved in the video survey of the RA-A storm sewers, performing decontamination, and within the *Exclusion Zone* shall don ***Modified Level C Protection for Potential Phosphorus Exposure*** as discussed in Section 7.3.3 of the SWHASP.

As the camera and wiring is removed from the storm sewers, the following decontamination procedures will be applied:

- Wash and scrub equipment with water as the camera and wiring is withdrawn from the sewer piping, taking care to only handle the cleaned portion of the equipment (while wearing the ***Modified Level C Protection for Potential Phosphorus Exposure***).
- Double or Triple-rinse with potable water.
- Capture all wash and rinse water in a metal container for later waste determination.
- Air dry the camera and wiring until completely dry. This will allow any remaining P4 to oxidize prior to stowage.

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4.2.3 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of sampling equipment including in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring).

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing surfaces that came into contact with native soils or slag.

4.3 GROUNDWATER MONITORING EQUIPMENT

The following procedure shall be used to decontaminate groundwater monitoring devices such as groundwater elevation meters and free product thickness meters. Spray bottles may be used to store and dispense distilled water.

- Wash equipment with laboratory-grade, phosphate-free detergent (e.g., Alconox™ or equivalent) and water, or steam clean.
- Triple-rinse with distilled water.
- Store in clean plastic bag or storage case.

5.0 PROCEDURE FOR OTHER WASTE DISPOSAL

While the decontamination Investigative Derived Waste (IDW) will be evaluated on a case-by-case basis, the general approach to be followed is detailed in SOP-4. Decontamination fluids (typically washwater) will be contained as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad or within the collection container). Washwater will then be containerized to await waste

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determination. Solids will also be containerized in a separate container to await waste determination.

6.0 REFERENCES

Environmental protection Agency, RCRA Ground-Water Monitoring: Draft Technical Guidance, November 1992. Page 7-17.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

This SOP has been revised from SOP No. 6 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

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1.0 INTRODUCTION

Surveying is the science of making the measurements necessary to determine the relative positions of points above, on, or beneath the surface of the earth, or to establish such points. This standard operating procedure (SOP) provides a description of the general types of surveys and requirements for performing these surveys. This SOP describes the applicability of the Global Positioning System (GPS) surveys, along with precision and accuracy required for each technique. This SOP is intended for the project leader to help develop work plans and manage resources. Note that in addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) while working on Site.

2.0 DEFINITIONS

Accuracy: Accuracy refers to the closeness between measurements and expectations or true values. The farther a measurement is from its expected value, the less accurate it is. Observations may be accurate but not precise if they are well distributed about the expected value, but are significantly disbursed from one another.

Accuracy is often referred to in terms of its order (i.e., first, second, or third order accuracy). The order of accuracy refers to the error of closure allowed; guidelines for each order of accuracy are as follows:

Order of Accuracy	Maximum Error
1st	1/25,000
2nd	1/10,000
3rd	1/5,000

Benchmarks: Monuments placed by surveyors to serve as permanent reference points. Benchmarks are elevation markers, and their location and elevation are precisely established and recorded on surveyors' level notes. They are set upon some permanent object to ensure they remain undisturbed.

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Global Positioning System (GPS): This system utilizes a network of overhead satellites orbiting the earth to locate objects and/or targets on the surface of the earth. Data from a minimum of three satellites is required to plot (by triangulation) the location of a certain point. Accuracy is dependent on the duration of data collection and the type of receiver/antenna used. All measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988.

Monuments: Physical objects that serve as landmarks for navigation. Classes of monuments include: natural, artificial, record, or legal. Examples of natural monuments are trees, large stones, or other substantial, naturally occurring objects in place before the survey was made. Artificial monuments can consist of iron pipe or bar driven into the ground, concrete or stone monument with a drill hole, cross, or metal plug marking an exact location (such as a corner). The standard for monumenting public-land surveys, as adopted by the Bureau of Land Management (BLM), is a post made of iron pipe filled with concrete. The lower end of the pipe is split and spread to form a base and the upper end is fitted with a brass cap with identifying marks. A record monument exists because of a reference in a deed or description (e.g., the gutter along a street). A legal monument is one that is controlling in the description (e.g., "to a concrete post").

Precision: Precision pertains to the distribution over a set of repeated observations of a random variable. It is a measure of the reproducibility of a result or measured value. Thus, if observations are closely clustered together, then the observations are said to have been obtained with high precision. Observations may be precise but not accurate if they are closely grouped about a value that is different from the expected or true value.

Station: A station is a 100-foot section of a measurement from a reference point such as a benchmark. For example, a stake placed 1,500 feet from a reference point is at station 15 and is labeled "15+00," and a stake placed 1,325 from a reference point is labeled "13+25."

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3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RD Project Manager: The RDRA Project Manager has overall responsibility for establishing the specific technical requirements and coordinating the survey services for the project. The RDRA Project Manager shall rely on input from FMC personnel and other key project staff who may have more detailed knowledge of the technical requirements and who would be on site to oversee the surveying. To facilitate the management and administration of surveying services procured for a particular site, the RDRA Project Manager may delegate responsibility to the Field Team Leader (FTL) as the focal point for all matters involving surveying services.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Responsible for implementation of the actual field activities performed on site including the measurement of sampling locations and to daily check the accuracy of the GPS instrument. In addition, the FTL shall be responsible for scheduling and coordinating field activities, overseeing survey activities, and preparing daily logs of field activities.

Surveyor (Surveying Contractor): In the event a licensed land surveyor is needed, the surveyor will be responsible for assuring that all surveying field operations, office calculations, map preparation, and related surveying activities conform to established guidelines and the specific requirements of the surveying subcontract (including health and safety requirements). All surveying operations shall be performed by, or under the direction of, a State of Idaho Licensed (or Registered) Land Surveyor, who shall sign and seal all final drawings, maps, and reports submitted as deliverables.

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4.0 GUIDELINES

The following sections provide guidelines for the performance of several types of surveys and the precision and accuracy required for each. Emphasis is placed on the application of surveying techniques to environmental investigations.

4.1 PERFORMING SURVEYS

There are many types of surveys that can be performed. This SOP describes the survey that will potentially be used at the FMC site. The survey will be used to establish northing and easting measurements and an elevation (feet above mean sea level). A Sokkia Axis, Trimble GEO Explorer, Trimble Pathfinder GPS or similar unit will be used for mapping test pits, boreholes, PIC and other sampling locations as well as being used for determining the thickness of soil covers. The selected unit must have an accuracy of 1 meter or less and will be checked daily with a known elevation of a benchmark. If the accuracy is greater than 1 meter, than the type of location data will be evaluated as to whether a professional surveyor is required. All measurements will be referenced to a State Plane Coordinate System, North American datum 1983 and the North American Vertical Datum 1988.

Global Positioning System (GPS) Surveying: GPS is a ranging system from known positions of satellites in space to unknown positions on land, sea, and in air or space. GPS uses the triangulation from orbiting satellites to establish the location derived from the broadcast of a satellite signal. The GPS unit measures the distance using the travel time of radio signals. The GPS concept assumes that four or more satellites will be available at any location on earth 24 hours a day.

Establishing Control (Benchmark): Prior to initiating any type of survey, a control shall be established at the site. The control point will be a surveyed benchmark used as a daily check for the accuracy of the GPS unit. If a benchmark is not available at the site or if access is limited, a fixed monument may be established by a licensed surveyor.

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Licensed Surveyor: In the event that a licensed surveyor is required for increased accuracy a State of Idaho Licensed Surveyor will be used at FMC. In the State of Idaho, the Idaho State Government Department of Commerce, Division of Occupational and Professional Licensing, administers licensing and certification programs.

Based on the project requirements, monuments may be set at the site that can be used in future site-surveys as a control point. Care shall be taken when establishing new control points and elevations from other agencies' vertical control points to ensure that all the old control benchmarks are on the same datum or reference plane. The monument shall be stamped with the state planar coordinates and the elevation (feet above mean sea level) such that it shall serve as a reference point for additional surveys. This can save time in future survey work as the surveying contractor will not have to survey new locations from distant established control points.

4.2 REQUIRED ACCURACY AND PRECISION

The required survey accuracy and precision depends on the intended purpose of the survey work. Sampling locations are to be surveyed within 1 meter or less both horizontally and vertically. Higher accuracies may be required for boundary surveys, topographic surveys, etc. The following sections discuss accuracy and precision requirements for specific survey types.

Marking Sampling Locations: The sampling location will be marked in the field using a stake with the corresponding sample number in the event that the location is revisited for additional sampling or surveying.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE MANAGEMENT

This SOP has been revised from SOP No. 7 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT

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1.0 INTRODUCTION

Investigation-derived waste (IDW) may be generated during the field investigation activities conducted under the planned performance evaluation and data gap investigations at the FMC Plant Operable Unit during 2013. The National Contingency Plan (NCP), codified in 40 Code of Federal Regulations (CFR) 300, requires that IDW be handled to attain all the applicable or relevant and appropriate requirements (ARARs) to the extent practicable, considering the urgency of the situation. The purpose of this SOP is to present procedures to be followed in the management of IDW generated during these field activities.

Potential IDW that may be generated during field activities are solid wastes and may include (but are not limited to) the following media and waste types:

Fluids	Solids
Groundwater well development / purge	Soils and soil cuttings
Drilling mud	Plastic tarps or sheeting
Grout	Drill pipe and well casing/screen
Decontamination fluids and wastewater	Decontamination solids
	Disposable equipment (i.e., rope, bailers, sampling equipment, & other consumables)
	Spent personal protective equipment (PPE)
	Used containers, sample bottles
	Packaging materials

The above wastes may or may not be encountered, generated or managed while performing the 2013 field activities. However, all solid waste streams will be characterized to determine if they are hazardous wastes per 40 CFR § 262.11 for the purposes of handling and disposal. Guidance from this document shall be used as part of project planning to estimate total volumes of IDW likely to be generated during the anticipated 2013 field activities as well as how the IDW will be managed and disposed.

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2.0 DEFINITIONS

Area of Contamination (AOC) unit: The AOC unit concept is critical to the IDW management at a CERCLA investigation site. Although EPA has not promulgated a definition of an AOC unit, an AOC unit is generally an area within a CERCLA investigation site with similar characteristics with respect to contamination and the associated risks to human health and the environment. A CERCLA investigation site may contain one or more AOC units. AOC units for the FMC Plant Operable Unit, which may be different from the Remediation Units (RUs) as used in the *SRI Work Plan for the FMC Plant OU* and/or the Remediation Areas (RAs) used in the *SFS Report for the FMC Plant OU*, will be delineated based upon exiting information, information gathered during the SRI, and visual observation as well as consideration of IDW management.

Decontamination fluids: Any fluids, including aqueous wash water, solvents, and contaminants that are used or generated during decontamination procedures.

Decontamination solids: Any solids, including soils and soil cuttings, fill materials, and contaminants that are generated during decontamination procedures.

Grout: A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed as required.

Hazardous waste: A solid waste that meets the definition of a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Hazardous IDW: An investigation derived waste that is also a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Investigation-derived waste (IDW): Solid wastes, as defined in 40 CFR § 261.2, directly generated as result of performing the 2013 field activities at the FMC Plant OU.

Nonhazardous waste: A solid waste that does not meet the definition of a hazardous waste as defined in 40 CFR § 261.3 or is excluded from hazardous waste regulation per 40 CFR § 261.4(b).

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Soils and soil cuttings: Solid material generated from excavation or drilling processes. Soils may include native soils, fill materials, and/or other historical plant waste streams used as fill materials on the site.

Solid waste: Any waste stream (solid, liquid or containerized gas) that meets the definition of solid waste under RCRA as defined in 40 CFR § 261.2.

3.0 RESPONSIBILITIES

This section presents a brief definition of the field team roles and responsibilities for management of IDW generated while conducting the 2013 field activities. This list is not intended to be a comprehensive list as additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible to ensure that all field team members are properly trained per their responsibilities associated with IDW and that appropriate equipment and facilities are available for appropriate IDW management.

Field Team Leader (FTL): Implements the field program and supervises all field team members in the appropriate management of IDW. Ensures that only properly trained personnel are managing IDW on the site.

Environmental, Health and Safety (EHS) Officer: Assists the Field Team Leader in the supervision of all IDW management on site. The EHS officer shall be responsible for all IDW identification and characterization, on site disposal, off site shipment and disposal, waste accumulation, emergency response and contingency planning, IDW training, and IDW reporting and recordkeeping.

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Project Team Members: Ensure that they are properly trained prior to any IDW management as well as follow the appropriate IDW procedures and training.

4.0 REGULATORY BASIS AND GUIDANCE

IDW encountered, generated, or managed during the 2013 field activities may contain hazardous substances as defined by CERCLA. Some IDW may be hazardous wastes under RCRA while others may be regulated under other federal laws such as TSCA. These regulatory requirements may be applicable or relevant and appropriate requirements (ARARs) which impact how the IDW is managed. Note that hazardous wastes under RCRA and/or wastes regulated under TSCA are not expected to be encountered, generated, or managed as part of the 2013 field activities. However, waste determinations will be performed and documented on all waste streams.

4.1 EPA GUIDANCE ON IDW MANAGEMENT

The management of IDW generated during the 2013 field activities shall be in accordance with EPA Guidance "Management of Investigation-Derived Wastes During Site Inspections", May 1991 (EPA, 1991). This guidance is based upon EPA's strategy for managing IDW based upon the following concepts:

- The National Contingency Plan (NCP) directive that CERCLA site investigations (SI) comply with applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

- The Area of Contamination (AOC) unit concept.

The specific elements of EPA's guidance for IDW management are as follows:

- Characterizing IDW through the use of existing information (manifests, MSDSs, previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgement.

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- Delineating an AOC unit for leaving RCRA hazardous soil cuttings within the unit.

- Containerizing and disposing of RCRA hazardous groundwater, decontamination fluids, PPE, and disposable equipment at RCRA Subtitle C facilities.

- Leaving on-site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids preferably without containerization and testing.

In general, EPA does not recommend removal of wastes from sites, in particular, from those sites where IDW do not pose any immediate threat to human health or the environment. Actions taken during the 2013 field activities with respect to IDW, that leave conditions essentially unchanged, should not require a detailed analysis of ARARs or assurance that conditions at the site will comply with the ARARs. At the same time, field personnel conducting the 2013 field activities should ensure that their handling of IDW does not create additional hazards at the site.

In brief, compliance with the NCP can generally be assured by:

1) Identifying contaminants, if any, present in the IDW based upon existing information and best professional judgement; testing is not required in most circumstances.

2) Determining ARARs and the extent to which it is practicable to comply with them.

3) Delineating an AOC unit based upon existing information and visual observation if soil cuttings are RCRA hazardous.

4) Burying RCRA hazardous soil cuttings within the AOC unit, so long as no increased hazard to human health and the environment will be created. Containerization and testing are not required.

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5) Containerizing RCRA hazardous groundwater and other RCRA hazardous IDW such as PPE, disposable sampling equipment, and decontamination fluids for off-site disposal.

4.2 HAZARDOUS WASTE REGULATION

The RCRA hazardous waste regulations are clearly ARARs for hazardous IDW generated and managed during the 2013 field activities. However, with the application of EPA IDW guidance, RCRA requirements apply to management of IDW in the following manner:

- If RCRA hazardous IDW is stored or disposed off-site, then comply with all RCRA (and other ARAR) requirements.

- If RCRA hazardous IDW is stored on-site, then comply with RCRA (and other ARAR) requirements to the extent practicable.

For the 2013 field activities, the following general guidance is expected to be practicable and therefore followed, recognizing that each situation will be evaluated against EPA IDW guidance (EPA, 1991) as well as RCRA hazardous waste requirements and other ARARs:

- IDW may be assumed not to be a “listed” hazardous waste under RCRA 40 CFR 261 Subpart D, unless available information about the site suggests otherwise.

- IDW characterization to determine if the IDW exhibits RCRA hazardous waste characteristics do not typically require testing if the characterization can be made by “applying knowledge of the hazardous characteristics in light of the materials or processes used” or by historical testing consistent with 40 CFR § 262.11(c).

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- Compliance with the RCRA hazardous waste generator requirements of 40 CFR Part 262 for all RCRA hazardous IDW generated and/or managed (with exception of soil cuttings managed in accordance with the EPA IDW guidance). It is presumed that the RCRA hazardous IDW generated will fall within the large quantity generator (LQG) requirements.

- Land disposal does not occur (and thus the Land Disposal Restrictions [LDR] of 40 CFR Part 268 are not applicable) when IDW soil cutting wastes are:

  - Moved, stored or left in place within a single AOC unit;
  - Capped in place;
  - Treated in situ (without moving the IDW to another AOC unit for treatment); or
  - Processed within the AOC unit to improve structural stability (without placing the IDW into another AOC unit for processing).

- Conversely, land disposal does occur (and the LDR of 40 CFR Part 268 are applicable) when IDW soil cutting wastes are:

  - Moved from one AOC unit to another AOC unit for disposal;
  - Moved outside an AOC unit for treatment or storage and returned to the same AOC unit for disposal;
  - Excavated from an AOC unit and placed in a container, tank, surface impoundment, etc. and then re-deposited back into the same AOC.

5.0 DESCRIPTION OF ANTICIPATED IDW MANAGEMENT

The following subsections provide a description of the anticipated IDW to be encountered, generated, and/or managed at the FMC Plant Operable Unit during the 2013 field activities and the anticipated management of each. It should be noted that this information is provided for planning purposes, and will be evaluated and may need to be revised based upon actual experience and waste determinations while on site.

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5.1 SOIL AND SOIL CUTTINGS

During the 2013 field activities, numerous test pits, trenches, and borings will be performed within the Western Undeveloped Area (WUA) of the FMC Plant Operable Unit to gain access to appropriate depths for soil sampling and to provide a source of clean soil for the test gamma cap. The WUA was determined during the SRI to be un-impacted, therefore, soils from this area will be managed as clean soils. There will also be extraction wells and sampling wells installed at the northeast corner of the FMC Plant OU. In addition to native soils, fill materials including slag and phosphate ore are expected to be encountered. Past analyses of these fill materials have determined that these fill materials do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all soil and soil cuttings managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Leaving on-site RCRA nonhazardous soil cuttings within the AOC where they are generated. Typically, this will involve placing soil cuttings back into the same investigation pit, trench, or bore hole (except finished wells) and in the same order from which the material was removed, to the extent practicable. For example, and effort will be made to segregate fill materials from native soils as soil cuttings are removed from a pit, trench, or bore hole. For finished wells, the soil cuttings will be spread out at the surface near the bore hole. The placement of the soil cuttings back into the pit, trench or bore hole will typically involve placement of the native soils back first, followed by the fill materials. This should ensure that there are not additional hazards created at the site and that site conditions remain essentially unchanged.

5.2 WELL DEVELOPMENT AND PURGE FLUIDS

During the 2013 field activities, groundwater extraction wells and piezometers are anticipated to be installed in the northeast area of the FMC Plant Site. Fluids will be

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generated during the development the wells and piezometers and purge water will be generated during the planned pump testing of the extraction wells. Over 20 years of analyses of groundwater from monitoring wells in the proximity of the planned wells / piezometers do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all well development and purge fluids managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Containment of well development / purge fluids as generated to await waste determination.

- Characterizing the well development / purge fluids through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The well development / purge liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- Any well development / purge liquids that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

5.3 SPENT SAMPLING-RELATED EQUIPMENT

During the 2013 field activities, spent sampling-related equipment may be generated. This may include (but not limited to) plastic sheeting/tarps, rope, bailers, sampling equipment, spent PPE, sample bottles, used containers, packaging materials, and other

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consumables. The spent sampling-related equipment is expected to be nonhazardous, based upon historical and SRI data collected.

While the spent sampling-related equipment will be evaluated on a case-by-case basis, the general approach to be followed for spent sampling-related equipment IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containerizing the spent sampling-related equipment at the point of generation.

- Characterizing the spent sampling-related equipment IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- Those spent sampling-related equipment IDW that are determined to be nonhazardous will be disposed along with other Site non-hazardous solid waste.

- Those spent sampling-related equipment IDW that are determined to be hazardous (although not expected) will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

5.4 DECONTAMINATION FLUIDS AND SOLIDS

5.4.1 Decontamination Fluids and Solids Associated with Drilling, Digging, and/or Trenching

During the 2013 field activities, decontamination fluids and solids will be generated. Typically, these will be generated at a common decon area, although there may be more than one decon area. Typically, the decontamination IDW will include (but not limited to) washwater from equipment, cleaning agents, cleaning utensils, and spent PPE (along with associated contaminants). Although this decontamination IDW is expected to be nonhazardous, waste determinations will be performed on each waste stream.

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5.4.2 Decontamination Fluids and Solids Associated with Sewer Pipe Investigation

Decontamination fluids and solids are expected to be generated during the video inspection of the storm sewers in RA-A. This is the only 2013 field activity in which field equipment is expected to come into contact with site materials contaminated with elemental phosphorus (P4). While the decontamination wash and rinse waters are expected to be non-hazardous, they may contain small amounts of P4.

5.4.3 Decontamination Fluids and Solids Waste Management

While the decontamination IDW will be evaluated on a case-by-case basis, the general approach to be followed for decontamination IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containment of decontamination fluids (typically washwater) as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad). Washwater will then be containerized to await waste determination. Solids will also be containerized in a separate container to await waste determination.

- Other decontamination solids such as cleaning utensils and PPE will also be containerized to await waste determination.

- Characterizing the decontamination IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The decontamination solids IDW that are determined to be nonhazardous will be disposed in on-site.

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- The decontamination liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- The decontamination IDW (either liquid or solid) that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

6.0 PROCEDURES FOR HAZARDOUS IDW MANAGEMENT

Although hazardous IDW is not expected to be generated, the following procedures apply to all IDW that have been determined to be hazardous except for soil cuttings IDW that remain with the AOC unit.

6.1 INTRODUCTION

Once an IDW has been determined to be hazardous, the federal RCRA Subtitle C waste management requirements apply to that waste. The scope of this procedure covers the requirements for large quantity generators of hazardous IDW which manage the hazardous IDW on site such that RCRA permitting is not required.

6.2 DETERMINE LAND DISPOSAL RESTRICTIONS

The 1984 amendments to the RCRA law included a prohibition of land disposal of certain hazardous wastes without first meeting some treatment standards. For the most part, all listed and characteristic hazardous wastes must be treated according to the treatment levels and technologies outlined in 40 CFR Part 268 to reduce the toxicity and/or mobility of hazardous constituents prior to being disposed of on the land, i.e., landfilled. Therefore, a generator must determine if the waste is a "restricted waste" under the land ban rules, and if so, off site treatment and disposal is limited. Note that these rules apply only to wastes destined for land disposal which is defined as: placement in or on the land including a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation,

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underground mine or cave, or concrete vault or bunker. Wastes which are shipped off site for disposal other than land disposal are not regulated under the land disposal restriction regulations of 40 CFR Part 268.

Generators of hazardous wastes must determine if the waste is restricted from land disposal under 40 CFR Part 268. The following reporting and recordkeeping requirements apply.

- If a generator determines that he is managing a restricted waste and the waste does not meet the applicable treatment standards, with each shipment of waste, the generator must notify the treatment or storage facility in writing of the appropriate treatment standards;
- If the generator determines that he is managing a restricted waste and the waste can be disposed without further treatment, with each shipment of waste, the generator must submit to the treatment, storage or disposal facility a notice and certification stating that the waste meets the applicable treatment standards;
- If the generator determines that he is managing a waste subject to an exemption from a prohibition on the type of land disposal method utilized for the waste, with each shipment of waste, the generator must submit to the receiving facility a notice stating that the waste is not prohibited from land disposal;
- If the generator is managing prohibited waste in tanks, containers, or containment buildings regulated under 40 CFR 262.34, and is treating such waste in such tanks, containers, or containment buildings to meet applicable treatment standards, the generator must develop a waste analysis plan which describes the procedures the generator will carry out to comply with the treatment standards; and
- If the generator determines whether the waste is restricted based solely on his knowledge of the waste, all supporting data used to make this determination must be retained on-site in the generator's files.

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The generator must retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to these requirements for at least three years from the date the waste was last shipped from the site. It should also be noted that it is prohibited to dilute a hazardous waste in order to circumvent the land disposal prohibitions (40 CFR 268.3). Once a waste is determined to be a "restricted waste", an appropriate Treatment, Storage, and Disposal Facility (TSDF) can be selected to properly treat and dispose of the waste.

6.3 ON-SITE ACCUMULATION

As discussed in Section 5.0 above for each IDW generated, a large quantity generator (LQG) must make the appropriate hazardous waste determination per 40 CFR Part 262.11. If the IDW is determined to be hazardous, then the IDW will typically be stored on-site prior to shipment off-site for disposal. The following requirements apply to all hazardous IDW being stored on-site prior to shipment.

6.3.1 EPA Identification Number (40 CFR Part 262.12)

Any facility which is a LQG of hazardous wastes must not treat, store, dispose, transport or offer for transportation any hazardous waste without first obtaining a EPA identification number from EPA (or the authorized state). Hazardous wastes cannot be offered to transporters or to treatment, storage or disposal facilities that have not received a EPA identification number. The FMC Plant Operable Unit has an EPA ID number of IDD070929518 which will be used on all manifests for shipments of hazardous IDW for off-site disposal.

6.3.2 On-Site Hazardous Waste Accumulation (Storage) (40 CFR 262.34(d))

Two types of accumulation areas for hazardous waste are permissible for a LQG without RCRA interim status or a Part B permit. These are the "90-day storage area" and the "satellite accumulation station" (SAS). The SAS requirements are discussed below. With regards to a "90-day storage area", a LQG may store hazardous wastes on-site for up to 90 days or less in a storage area, provided that the following conditions are met:

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- If the waste is placed in containers, the requirements of 40 CFR Part 265 Subpart I (container requirements) are met. See below for container requirements;
- If the waste is placed in tanks, the requirements of 40 CFR 265 Subpart J (tank requirements) are met. See below for the tank requirements.
- At closure, the generator closes the storage area per the requirements of 40 CFR 265.111 and 40 CFR 265.114;
- The date which the hazardous waste is placed in the storage area is clearly marked on the container, and the container is clearly marked as "Hazardous Waste";
- The facility complies with 40 CFR Part 265 Subpart C, Preparedness and Prevention (See Section 6.3.3 below);
- The facility complies with 40 CFR Part 265 Subpart D, Contingency Plan and Emergency Procedures (See Section 6.3.4);
- The facility complies with 40 CFR Part 265.16 training requirements (See Section 6.6 below);
- Any hazardous wastes which are stored longer than 90 days must first be granted an extension by EPA (or authorized state).

90-Day Storage Area Container Requirements (40 CFR Part 265 Subpart I)

Hazardous waste stored in containers must meet the following requirements:

- Containers must be in good condition, free of leaks;
- Hazardous wastes must be compatible with container (or liner) material;
- Containers must always be kept closed except to add or remove wastes;
- Containers must be handled in a manner to avoid ruptures;
- The storage area must be inspected at least weekly to check for container deterioration; and
- Incompatible wastes must be stored separately with separate secondary containment.

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Incompatible wastes are wastes that are unsuitable for co-mingling because the co-mingling could result in any of the following:

- Extreme heat or pressure generation;
- Fire;
- Explosion or violent reaction;
- Formation of substances that have the potential to react violently;
- Formation of toxic dusts, mists, fumes, gases, or other chemicals; and/or
- Volatization of ignitable or toxic chemicals due to heat generation.

90-Day Storage Area Tank Requirements (40 CFR Subpart J)

LQGs that accumulate or store hazardous wastes in tanks or tank systems must meet the following requirements:

- For tanks existing prior to July 14, 1986, an assessment of tank must be performed and certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.191);
- New tank systems (those built after July 14, 1986) must meet tank technical standards and have been certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.192);
- New tank systems must have adequate secondary containment and leak detection systems. Existing tanks must be upgraded to meet these standards by the time the tank is 15 years of age (40 CFR 265.193);
- Tanks must be operated to prevent system failure, overflow and spills. Tanks must be operated with sufficient freeboard to prevent overtopping (40 CFR 265.194);

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- Inspect the tanks at least once each operating day for the following:
    - Discharge control equipment;
    - Monitoring equipment and controls;
    - Tank level; and
    - Evidence of leaks or spills. (40 CFR 265.195)
- Inspect the tanks at least weekly for corrosion, erosion or leaks;
    - The tank must meet the closure and post-closure care provisions of 40 CFR 265.197; and
    - Store incompatible wastes separately (40 CFR 265.199).

Satellite Accumulation Station (SAS) Requirements (40 CFR 262.34(c))

A SAS is a container placed at or near the point of waste generation for the purpose of collecting the waste as it is being generated. For example, a container may be placed in the quality control laboratory for collection of hazardous wastes generated in the laboratory. This SAS may collect up to 55 gallons of hazardous waste or 1 quart of acute hazardous waste. The SAS does not need to meet the requirements of a storage area, provided the following conditions are met:

- The amount of hazardous waste accumulated at the SAS does not exceed 55 gallons (or 1 quart of acute hazardous waste);
- The SAS is located at or near the point of generation where the waste is initially accumulated and is under the control of the operator of the process generating the waste;
- The container used is in good condition, is compatible with the wastes being accumulated, and is kept closed except to add or remove wastes;
- The container is marked with the words "Hazardous Waste" or other words to identify the contents; and

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- Once the 55-gallon limit is reached, the date is marked on the container and the container is moved from the SAS within three days to a proper location. For example, the wastes must either be moved to the storage area or be picked up by a waste transporter and moved off-site.

6.3.3 Preparedness and Prevention (40 CFR Part 265 Subpart C)

The following preparedness and prevention steps must be taken concerning the hazardous waste storage area:

- The storage area must be operated and maintained to minimize the possibility of fire, explosions or releases of hazardous waste;
- The facility must have appropriate communication systems, fire-fighting equipment, spill control equipment and decontamination equipment;
- All emergency response systems and equipment must be tested monthly with documentation and maintained to assure proper operation;
- Persons handling hazardous wastes must have immediate access to alarms and/or communication systems;
- The storage area shall have adequate aisle space for emergency response activities; and
- The facility must attempt to make arrangements with the local police, fire departments, emergency response teams, and local hospitals to assure readiness for potential emergencies associated with the storage area.

6.3.4 Contingency Plan and Emergency Procedures (40 CFR Subpart D)

A LQG that accumulates or stores hazardous waste on site in a 90-day storage area must develop and keep current a contingency plan for the facility. The purpose of the contingency plan is to provide an organized plan of action and delegation of responsibilities and authority to specific facility personnel to respond to emergency situations that may require both the facility and/or outside resources. The contingency plan is designed to minimize hazards to humans or the environment from fires, explosion

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or any unplanned sudden or non-sudden release of hazardous waste/hazardous waste constituent to air, soil or surface water in compliance with the requirements of 40 CFR 265 Subpart D. MWH will maintain a Contingency Plan on the site if hazardous IDW are accumulated on-site.

The key components of the contingency plan include the following (40 CFR 265.52):

- A description of the emergency response organization, including designation of the Emergency Coordinator and alternates;
- Response procedures;
- Emergency notification;
- Arrangements with local authorities;
- List of names, addresses and phone numbers of designated emergency personnel and alternates;
- List of emergency response communication equipment and locations;
- Evacuation procedures, routes and alternates; and
- Procedures for amending the plan.

Copies of the plan must be sent to (40 CFR 265.53):

- The FMC Project Manager;
- Power County Sheriff's department;
- Pocatello fire department; and
- Other agencies as deemed appropriate.

The emergency coordinator (EC) is the key person facilitating emergency preparedness and response. The EC or designated alternate shall be on-site or on-call at all times. The EC and alternates must be trained and thoroughly familiar with the contingency plan, emergency response activities and operation of the facility. The EC must know the

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locations and characteristics of all waste generated, location of all records within the facility and the facility layout. The EC must have the authority to commit the resources needed to carry out the spill response plan. Any person or department who first discovers any spill of a hazardous waste/material is responsible for notifying the spill response/emergency response coordinator. The EC for the 2013 field activities will be the EHS Officer with the Field Team Leader and the RDRA Project Manager as alternates.

The contingency plan should be reviewed and immediately amended when:

- Changes in applicable regulations occur;
- The plan fails in an emergency;
- Changes are made to emergency procedures;
- Changes occur in emergency personnel list; or
- Changes occur in emergency equipment list.

6.4 PRE-TRANSPORTATION REQUIREMENTS

Prior to transporting hazardous wastes or offering hazardous wastes for transportation off-site, the generator must comply with the following:

- Package the hazardous wastes in DOT-approved containers per 49 CFR Parts 173, 178 and 179. DOT-approved containers (such as drums) are usually marked as being DOT-approved);
- Label the hazardous wastes according to DOT labeling requirements per 49 CFR Part 172;
- Mark each container (of 110 gallons or less) used in transportation with the following:

  HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the EPA.

  - Generator's Name and Address

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- Manifest Document Number

- Ensure that the initial transporter placards the transport vehicle with the appropriate placard in accordance with 49 CFR Part 172 Subpart F.

6.5 MANIFESTING OFF-SITE SHIPMENTS OF HAZARDOUS IDW

Any generator which transports or offers for transportation hazardous waste for off-site treatment, storage or disposal must prepare a manifest according to manifest instructions for each shipment of similar hazardous wastes. The manifest must be carefully filled out with each shipment. Take care to follow the instructions and use the terms as listed in the instructions. A generator must designate on the manifest one facility (designated facility) which is permitted to handle the waste described on the manifest (40 CFR 262.20).

The generator must determine if the state to which the wastes are destined (consignment state) requires use of its own manifest. If so, then the consignment state's manifest must be used. If the consignment state does not require use of its manifest, and the state in which the waste shipment originates (generator state) does, then the manifest from the generator state must be used. If both states have manifests, use the consignment state manifest, making sure that there are sufficient copies to meet the generator state distribution requirements. If neither state requires use of its manifest, then any uniform hazardous waste manifest may be used (40 CFR 262.21).

The manifest must contain at least enough copies such that the generator gets two copies, the transporter gets one copy and the designated facility gets one copy. Some states require additional copies to be sent to the state. At the time of shipment, the generator must keep one copy (the generator copy) of the completed, signed manifest and give the remaining copies to the transporter. Each copy must have the signature of the generator and the transporter at the time of shipment. The original manifest shall be returned to the generator once the shipment reaches the designated facility and the manifest is signed by the designated facility (40 CFR 262.21).

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If the original, signed manifest is not received by the generator within a certain number of days, action by the generator is required. These requirements are discussed in the following sections:

- If, after 35 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must contact the transporter and/or the designated disposal facility to determine the status of the hazardous waste (40 CFR 262.42(a)(1)).
- If after 45 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must submit an exception report to the U.S. EPA (or authorized state). The exception report must include a copy of the manifest along with an explanation of efforts to locate the hazardous wastes and the result of these efforts (40 CFR 262.42(a)(2)).

6.6 PERSONNEL TRAINING

Any person, and their immediate supervisor(s), involved in waste management at a LQG facility which stores hazardous waste in a 90-day storage area must undergo initial and annual training for hazardous waste management (40 CFR 262.34(a)(4) and 40 CFR 265.16). Facility personnel are required to successfully complete a program of classroom instruction or on-the-job training that teaches them to perform hazardous waste management duties relevant to their jobs. The program must be directed by a person trained in hazardous waste management procedures.

The training must be designed to enable personnel to effectively respond to emergencies by becoming familiar with emergency procedures, emergency equipment and emergency systems, including the following;

- Procedures for using, inspecting, repairing and replacing facility emergency and monitoring equipment;
- Communications or alarm systems;
- Response to fires or explosions; and

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- Off-site communication.

Employee training is to be held at regular intervals. Emergency planning information, e.g., the Contingency Plan, also should be provided to state and local emergency response agencies at regular intervals (40 CFR 265.37 and 265.53). Employees required to receive the training cannot work unsupervised until they have completed the training requirements (either classroom or on-the-job training). In addition, facility personnel must take part in an annual review of the initial training.

The following records must be maintained at the facility for employees affected by this training:

- Job title for each position and name of employee filling each job;
- Job descriptions for each position related to hazardous waste management;
- Written description of type and amount of initial and continuing training that will be given to each person filling the various job positions; and
- Documentation that necessary training has been given and completed by each affected personnel.

Training records are required to be kept on current personnel until closure of the facility. For former employees, training records must be kept for at least three years from the date the employee last worked at the facility and may be transferred if the employee stays within the same company (40 CFR 265.16(e).

6.7 REPORTING AND RECORDKEEPING

The following reports are required of a LQG:

- Manifest exception reports as discussed in Section 6.5 above.

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- A LQG must submit a Biennial Report to the EPA (or authorized state) every even numbered year by March 1, e.g., March 1, 2008 for the 2007 reporting year. The Biennial Report is to be submitted on EPA form 8700-13A.

The following records are required to be kept for a minimum of three years by the LQG:

- The signed original manifests;
- Biennial reports;
- Exception reports;
- All records pertaining to hazardous waste determinations; and
- Land disposal determination records, notification and certification records.

7.0 REFERENCES

EPA, 1991. Management of Investigation-Derived Wastes During Site Inspections, EPA May 1991, EPA/540/G-91/009

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FMC Idaho LLC, Pocatello, Idaho

FMC OU Remedial Design
GAMMA CAP PERFORMANCE EVALUTATION WORK PLAN

July 2013

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APPENDIX

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1.0 INTRODUCTION

As specified in Section 10.2 of the Interim Amendment to the Record of Decision for the EMF Superfund Site – FMC Operable Unit (IROD, EPA 2012), gamma caps will be installed at Remediation Areas (RAs) A, A-1, F and G that will provide protection with respect to both gamma radiation and soil ingestion exposure pathways. An evapotranspirative (ET) cap is the selected remedy for other areas of the Site that exceed the incremental cancer risk remedial action objective (RAO) to future Site outdoor workers and also pose a threat to groundwater. Due to the additional soil thickness, an ET cap provides an equal or greater level of protection for gamma radiation and soil ingestion pathways as compared to the gamma cap. ET caps will be installed at RAs B, C, D, E, F-1, F-2, H and K. The FMC OU RAs and are shown on Figure 1-1.

On June 10, 2013, EPA Region 10 issued to FMC a Unilateral Administrative Order for Remedial Design and Remedial Action (RDRA Order; EPA 2013), EPA Docket No. CERCLA-10-2013-0116. The RDRA Order defines the specific actions FMC will undertake to design and implement the Selected Remedy at the FMC OU in accordance with the IROD. This *Gamma Cap Performance Evaluation Work Plan* (*Gamma Cap Work Plan*) has been prepared and submitted to meet the requirements of Section IX, Paragraph 30 d.2.bb. of the RDRA Order for the Gamma Cap Thickness Effectiveness Test, and has been prepared in accordance with *Superfund Remedial Design and Remedial Action Guidance* (EPA, 1986). As stated in the RDRA Order, the gamma cap performance evaluation objectives are:

1. To determine whether the one foot of native soil cap or “gamma” cap meets the external gamma radiation Performance Standard (and RAO) in the IROD, or whether more material is required; and
2. To develop construction quality assurance and quality control (QA/QC) methods to demonstrate achievement of the Performance Standard.

1.1 BACKGROUND

1.1.1 Areas Specified for Gamma Cap Remedy

As stated in the IROD, a gamma cap when combined with the appropriate core elements (primarily institutional controls that limit re-distribution of fill materials after cap placement), meets site RAOs for potential human exposure through pathways including: 1) gamma radiation, 2) incidental ingestion, 3) direct dermal exposure, and 4) inhalation of fugitive dust. Therefore, a gamma cap was identified as an element of the selected remedy for those areas that are covered by fill materials (i.e., phosphate ore and slag), and do not pose a threat to groundwater.

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The gamma cap involves placement of one foot of native soil over fill or soil within specified RAs. After grading to establish the appropriate subgrade slopes to minimize potential run-on/run-off erosion damage, gamma caps will be installed at the following RAs:

RA-A: The northern plant boundary, which abuts Highway 30, forms the northern boundary of this area. RA-A is covered with non-leachable fill including primarily slag, coke, silica, concrete, asphalt, and native soil.

RA-A1: This area was investigated during the Supplemental Remedial Investigation (SRI) and found to contain fuel poly-aromatic hydrocarbons (PAHs) above the soil screening levels (SSLs). Since the PAHs are a direct contact threat, use of a soil (gamma) cover over this area meets the RAOs.

RA-F: This area contains the slag pile and bullrock pile and former equipment maintenance/laydown areas. Surface and subsurface fill within this area consists predominantly of slag and bull rock (rejected oversized ore).

RA-G: This area contains the ore stockpiles, silica stockpile, industrial wastewater (IWW) pond and ditch, and dry process waste piles. Surface and subsurface fill within this area includes various plant solid materials including ore, baghouse dust, coke, carbon, calciner solids, and slag.

1.1.2 Areas Specified for ET Cap Remedy

As stated in the IROD, an ET cap when combined with appropriate institutional controls, will: 1) prevent exposure via all viable pathways (external gamma radiation, incidental soil ingestion, dermal absorption, and fugitive dust inhalation) to soils and solids contaminated with chemicals of concern (COCs) that would result in an unacceptable risk to human health under current or reasonably anticipated future land use; 2) reduce the release and migration of COCs to the groundwater from facility sources that may result in concentrations in groundwater exceeding risk-based concentrations (RBCs) or chemical-specific applicable or relevant and appropriate requirements (ARARs), specifically Maximum Contaminant Levels (MCLs), or reduce COCs to site-specific background concentrations if those are higher, and 3) for the RAs with known or suspected P4 in the subsurface, prevent direct exposure to elemental phosphorus under conditions where it may spontaneously combust and create a fire hazard or air emissions that would represent a significant risk to human health and the environment and minimize generation and prevent exposure to phosphine and other gases at levels that represent a significant risk to human health and the environment.

The ET cap involves constructing a cover of native soil and vegetation that provides sufficient water storage and ET capacity to store and remove precipitation, thereby minimizing or eliminating infiltration. ET cover systems also typically include a capillary break layer

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comprised of coarse material (e.g., cobbles) that limits the infiltration into the underlying fill and/or soil materials. The ET caps will be installed on RAs that are identified as posing a potential threat to groundwater due to release and migration of COCs from surface/subsurface soil/fill to groundwater. Installation of ET caps on the specified RAs also constitutes the source control remedy element of the groundwater Remedial Action. After grading to establish the appropriate subgrade slopes and stormwater drainage/collection, ET caps will be installed at the following RAs:

RA-B: This area encompasses the former furnace building, phosphorus loading dock, secondary condenser and slag pit, and encompasses the P4-impacted capillary fringe soils downgradient of these RUs. Surface and/or subsurface fill within this remedial area contains P4 (subsurface), phossy solids, precipitator solids, slag, ore, concrete, asphalt, and silica. Underground piping containing COCs (potentially including P4) is also present in RA-B.

RA-C: This area encompasses the former phossy/precipitator slurry ponds, the piping corridor leading from RA-B to the former ponds, and the Pond 8S recovery process. Surface and/or subsurface fill within this area contains P4 (subsurface), phossy solids, precipitator solids, slag, ore, ferrophos, concrete and asphalt. Underground piping containing COCs (potentially including P4) is also present in RA-C.

RA-D: This area encompasses the western portion of the former phossy/precipitator slurry ponds including Pond 9S. Surface and/or subsurface fill within this area contains phossy solids, precipitator solids, slag and ore, but no significant quantity of P4. RA-D is not known to contain P4 other than presumably in underground piping.

RA-E: This area encompasses the former ore kilns, kiln scrubber ponds, calciners, calciner pond solids stockpiles, silica stockpiles, and calcined ore stockpiles. No P4 is present, but surface/subsurface fill contains slag, ore, silica, and kiln pond solids (subsurface). A short segment of underground piping containing COCs (potentially including P4) is also present in this RA.

RA-H: This area contains the active plant landfill and the construction/demolition debris landfill. Surface and subsurface fill within this area contains solid waste including plant trash, Andersen filter media (AFM), asbestos, empty containers, concrete, carbon, and furnace feed materials (ore, silica, coke).

RA-K (the Railroad Swale): This area is located along the northeastern border of the FMC Plant Site and was used for stormwater retention. The Railroad Swale also received an intermittent flow of phossy water, known to contain low levels of P4 and phossy solids.

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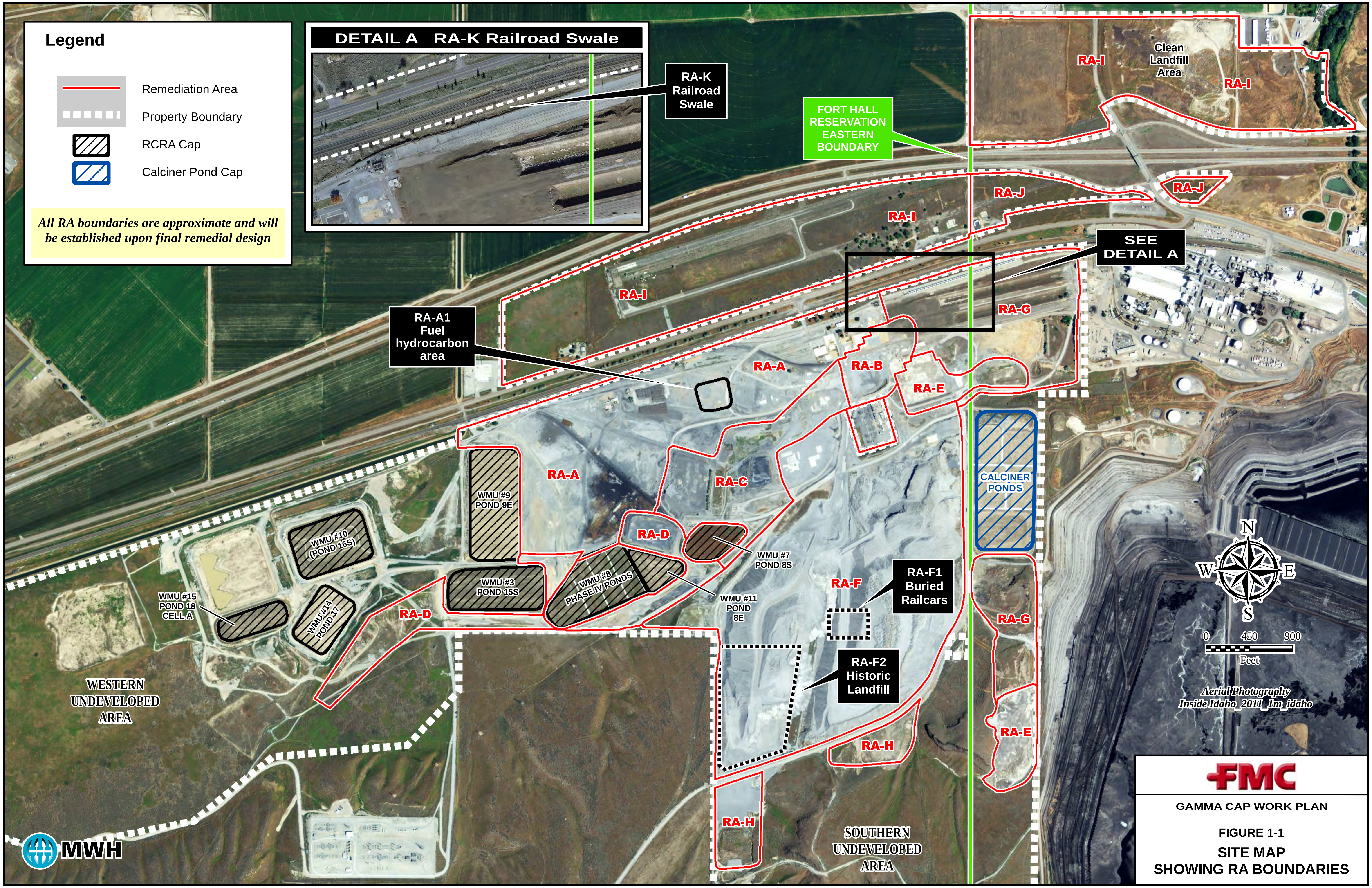
RA-F1 (Buried Railcars): This area is located in approximately the center of the slag pile and contains 21 buried railcars. The railcars were covered with 80 to 120 feet of slag as placement of slag on the pile progressed to the south.

RA-F2 (Former Plant Landfill): This area is located within the southwestern corner of the slag pile. As described in the *SRI Report for the FMC Plant Operable Unit* (*SRI Report,* MWH, 2009), the former landfill is covered by 50 to 140 feet of slag.

1.2 ORGANIZATION OF THIS WORK PLAN

The remainder of this *Gamma Cap Work Plan* is organized as follows:

- Section 2 presents the study objectives and details the calculation of the gamma exposure rate equivalent to the remedial action objective (RAO) and radium-226 clean up level as specified in section 7.2.2 of the IROD.
- Section 3 summarizes the gamma modeling performed to determine the appropriate location and dimensions of the test cap; design and construction methods and quality control for the test cap; and demonstration gamma measurements.
- Section 4 contains the quality assurance project plan (QAPP) and field sampling plan (FSP).
- Section 5 presents the procedures for data reduction, review and reporting.
- Section 6 incorporates by reference the Health and Safety Plan (HASP).
- Section 7 presents the project deliverables and schedule.
- Section 8 provides a list of references.
- Appendix A contains the data set and ProUCL output for the background gamma exposure rate.
- Appendix B contains the *Gamma Cap Model Report* (ERG, 2013).
- Appendix C contains the Standard Operating Procedures (SOPs) for this Work Plan



DATE: 29 May 2013

FILE: I:\projects\FMCIdaho\FMC_DataGapWP\FIGURES\Fig 1-1_FMC_Site Map showing RA Boundaries_May2013.mxd

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2.0 PERFORMANCE EVALUATION OBJECTIVES OF STUDY

2.1 OBJECTIVES

The gamma cap performance evaluation is proposed to provide information to support the design of the gamma cap during the Remedial Design and to demonstrate gamma cap construction methods including construction quality control/quality assurance (CQC/CQA). As stated in UAO Paragraph 30.d.2.bb., the gamma cap performance evaluation objectives are:

- To determine whether the one foot of native soil cap or "gamma" cap meets the external gamma radiation Performance Standard (and RAO) specified in the IROD, or whether more material is required; and
- To develop construction quality assurance and quality control (QA/QC) methods to demonstrate achievement of the Performance Standard.

For areas of the FMC Plant OU that contain fill materials but that do not pose a threat to groundwater, the selected soil remedy stated in the IROD is that a nominal one-foot native soil cap is sufficient to meet the incremental cancer risk RAO for gamma radiation and the radium-226 cleanup level specified at Section 7.2.2 and Table 9 of the IROD. As stated in Section 1.0 above in this *Gamma Cap Work Plan*, the selected soil remedy also includes ET caps over areas of the FMC Plant Site containing similar fill materials (i.e., phosphate ore and slag). As the ET caps will be constructed with at least twice the native soil thickness as a gamma cap, it is presumed that validation of the gamma cap as proposed in this performance evaluation will also validate ET cap performance with respect to the gamma radiation RAO and radium-226 cleanup level. Therefore, a separate performance evaluation of an ET cap against these requirements is not necessary.

By achieving the second performance objective listed above, FMC intends that the performance verification of the final gamma cap installation at RAs A, A-1, F, and G and the final ET cap installation at RAs B, C, D, E, F1, F2, H, and K will be based upon the demonstrated construction methods and associated construction quality assurance and quality control (CQA/CQC), making post-construction gamma measurements for gamma and ET cap performance verification unnecessary. This approach to performance verification for the final caps is required due to the presence of significant gamma radiation emanating from the adjacent Simplot gypsum stack to the east and felsic volcanic rock outcrops to the south of the areas to be capped on the FMC Plant Site.

Measureable gamma emissions (gamma shine) are prevalent on the eastern portion of the FMC Plant Site from the naturally occurring andesite/rhyolite outcrops in the Southern Undeveloped Area (SUA) and from the gypsum pile located immediately east of the FMC Plant Site eastern

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boundary. These gamma emissions are significant and indistinguishable from gamma radiation emanating from the fill materials that will be covered with a gamma cap. As a result, attempts to use direct gamma measurements for final gamma cap performance verification in the presence of these gamma emissions from non-FMC related sources would be ineffective. Note that for the purposes of this performance evaluation, it is important that the test gamma cap be located in an area of the FMC Plant Site that not only has significant levels of fill material but also is at a sufficient distance from adjacent, elevated gamma radiation sources (e.g., rock outcrop, slag pile, gypsum stack) to have minimal gamma influence from those sources. The western-most portion of the former Bannock Paving Area within RA-A is the most suitable area to meet these criteria.

Gamma exposure rate measurements will be taken on top of the installed test cover to assess compliance with the future outdoor worker radium-226 cleanup level. To perform this task, the exposure rate measurements will be compared to a gamma dose that is equivalent, in terms of risk level, to the 1E-04 incremental cancer risk remedial action requirement reflected in the radium-226 cleanup level of 3.8 pCi/g

2.2 GAMMA EXPOSURE RATE EQUIVALENT TO RADIUM-226 CLEANUP LEVEL

In order to evaluate the performance of the test gamma cap in meeting the radium-226 cleanup level of 3.8 pCi/g specified in the IROD, an equivalent gamma exposure rate was calculated as described in this section.

The gamma investigations performed during the 2007 SRI at the FMC Plant OU included a GPS-based surface gamma radiation survey, high pressure ionization chamber (HPIC) measurements, and co-located HPIC and sodium iodide detector (SID) measurements. HPIC measurements were made in the Western Undeveloped Area (WUA) and SUA; two areas of the plant that were not used for the phosphorus manufacturing process. As described in Appendix F (*Radiological Characterization Report* [RCR] *for the FMC Plant Site*) of the *SRI Report*, the gamma exposure rate measurements taken in the WUA during the SRI are representative of background at the FMC Plant Site. As also stated in the RCR, to appropriately evaluate background exposure rates in the undeveloped areas, it was necessary to address anomalies in the data sets. For the WUA exposure rate measurements, which are presented in Table 2-2 of the RCR and included in Appendix A of this Work Plan, measurements at locations 8, 34, 43, 52, 59, 61, 70, 75, 76, 80, 81, 84, 85, 88, 98, 99, and 100 had to be removed because they were clearly impacted by slag on nearby surfaces. Removal of these 17 measurements resulted in a data set of 83 measurements with exposure rates ranging from 13.5 to 16.3 μR/hr, averaging 14.4 μR/hr, and with a standard deviation of 0.6 μR/hr. To confirm that all of these measurements were representative of background levels, the six measurements taken within the WUA borrow pit area (created after shut down of the FMC plant) were compared to the remaining 77 WUA measurements taken outside the borrow pit. The means of the exposure rate measurements taken inside and outside the borrow pit were calculated to be 14.45 and 14.47 μR/hr, respectively. This finding confirmed

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that the exposure rates from the surface of the borrow pit area (with the topsoil removed) and the undisturbed WUA land surface are equivalent; i.e., there has been no historical surface deposition that has increased gamma exposure rates in undisturbed areas of the WUA above background levels.

To characterize background gamma at the FMC Plant Site, the 95 UCL WUA gamma exposure rate (excluding the 17 anomalous measurements described above) was calculated using Version 4.1 of EPA's ProUCL software. The ProUCL input data set and output calculation of the 95 UCL are presented in Appendix A of this Work Plan. The ProUCL recommended 95% Student's-t UCL or 95% Modified-t UCL are both 14.55 µR/hr.

Consistent with the calculations in Table 2-3 of the *SRI Work Plan for the FMC Plant OU* (*SRI Work Plan,* MWH, 2007), a gamma dose rate equivalent to the 1E-04 incremental cancer risk level reflected in the radium-226 cleanup level of 3.8 pCi/g was developed as follows:

$$\text{Gamma CV} = \frac{\text{TR}}{\text{CF x EF x ED x SF}}$$

Where:

Gamma CV = Gamma exposure rate (uR/hr) equivalent to a 1E-04 target cancer risk
TR = Target cancer risk from external gamma radiation exposure 1E-04 (unitless)
CF = Conversion factor (0.95 urad/uR),
EF = Exposure frequency (hours/year)
1800 hours/year (8 hrs/day and 225 days/yr) for outdoor commercial/industrial workers,
1040 hours/year for construction workers,
80 hours/year for utility workers
ED = Exposure duration (years)
25 years for outdoor commercial/industrial workers,
1 year for construction workers
1 year for utility workers
SF = External gamma radiation slope factor (8.46E-10/urad - Table 7.6 of *Federal Guidance Report No. 13: Cancer Risk Coefficients for Environmental Exposure to Radionuclides*).

Therefore:

<u>Outdoor Commercial/Industrial Worker:</u>
1E-04/(0.95 urad/uR x 1800 hr/yr x 25 yr x 8.46E-10/urad) = 2.8 uR/hr
<u>Construction Worker:</u>
1E-04/(0.95 urad/uR x 1040 hr/yr x 1 yr x 8.46E-10/urad) = 120 uR/hr
<u>Utility Worker:</u>
1E-04/(0.95 urad/Ur x 80 hr/yr x 1 yr x 8.46E-10/urad) = 1557 uR/hr

Therefore, the gamma exposure rate equivalent to the radium-226 cleanup level is 17.4 µR/hr (14.6 + 2.8 uR/hr; i.e., 95% UCL background + 1E-04 incremental cancer risk level for the worst-case outdoor commercial/industrial worker).

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3.0 GAMMA CAP PERFORMANCE EVALUATION DESCRIPTION

3.1 TEST GAMMA CAP MODELING

Prior to determining the dimensions and location for the test gamma cap, numerical modeling was performed to determine the effective infinite radius and depth of the slag and to predict the shielding effectiveness of the soil cover. The *Gamma Cap Model Report* (ERG, 2013) is provided in Appendix B. The gamma cap modeling input and results are summarized below:

- Gamma radiation emanation from slag was utilized in the model to represent slag, other fill materials (i.e., ore and/or ore-derived process wastes) or a mixture of slag and fill materials on the surface of RAs receiving gamma or ET caps. This assumption is reasonable as uranium-238 (and radium-226 in secular equilibrium) concentrations in ore are typically around 27 pCi/g while uranium-238 (and radium-226 in secular equilibrium) concentrations in slag are higher than ore or other fill materials with maximum laboratory results of around 30 pCi/g (MWH, 2009).
- The model results indicate that the exposure rate reaches a sustained maximum at a source radius and thickness of approximately 850 cm (28 feet) and 152.4 cm (5 feet), respectively. These values approach that of an infinite radius and thickness. Thus, if the test cap is located on an area of slag at least 5 feet thick and 60 feet in diameter, then the test cap performance will be representative of a cap over any greater thickness or areal extent of slag / fill materials (e.g., the slag pile).
- The model results indicate that a dry, 12-in. (30.48 cm) thick, sandy soil cover with a density of 1.4 g/cm^3 (87 pounds per cubic foot) attenuates photon emissions from an infinitely thick source of slag to an exposure rate (2.86 μR/hr) that is similar to the gamma exposure rate equivalent to the radium-226 cleanup level prescribed in the IROD and described in Section 2.2 of this *Gamma Cap Work Plan* (2.8 μR/hr above background).

Actual conditions (addition of moisture and use of silty clay in lieu of sand) are expected to further attenuate the photons emitted from the slag; hence, the exposure rate is expected to be slightly lower. As described in this section, field measurements on the test cap will be used to both validate the model and demonstrate compliance with the RAO and gamma exposure rate equivalent to the radium-226cleanup level.

3.2 TEST GAMMA CAP PLOT DESIGN

This section presents the design of the test gamma cap with respect to sourcing of cap soil, capsize and thickness, in-place soil density, and cap location.

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3.2.1 Cap Soil Borrow Source

The soil used for the gamma cap will be obtained from the WUA. Previous investigations have confirmed that soil in this area was not impacted by plant operations and thus is suitable for use as capping material. The soil in the WUA is characterized predominantly as silt with minor amounts of clay. Previous testing of this material, by Standard Proctor Compaction, indicates that the soil has an average Maximum Dry Density (MDD) of 103.8 lbs/ft^3 (pcf) at an optimal moisture content (OMC) of 18%.

3.2.2 Cap Size, Thickness, and Geometry

The constructed test gamma cap will encompass a minimum of 104 ft^2 by 104 ft^2 for a minimum total area of 0.25 acres (10,890 ft^2). This area is larger than the required infinite radius (approximately 28 feet) determined by the modeling results summarized in Section 3.1 and presented in Appendix B. The conceptual design of the gamma cap, presented in Section 13.1.10 of the IROD, consists of a 12-inch (1 foot) minimum cover thickness. As summarized in Section 3.1 of this Work Plan, a 12-inch gamma cap is capable of meeting the radium-226 cleanup level. Therefore, the test gamma cap plot will be constructed to achieve a minimum thickness of 12inches. For purposes of the performance evaluation, the cap will be constructed as a flat cap to facilitate grading and reduce the amount of material that needs to be placed.

3.2.3 Gamma Cap Compaction

The gamma cap will be constructed at a targeted density of 85% Standard Proctor Compaction and at the corresponding moisture content. As described in the *Gamma Cap Model Report*, the difference in modeled results with the soil compacted at 80%, 85%, and 90% showed very little sensitivity (approximately 0.5 μR/hr detector response per 0.1 g/cm^3 change in density) with respect to shielding gamma radiation. Model results at all three compaction efforts indicated adequate shielding of gamma radiation. Therefore, although the gamma cap trial plot will be constructed to a target in-place density of 85% of MDD, a tolerance of ±3% (82% to 88%) will be allowed. The desired moisture content will be OMC ±3%. Based on previous testing of borrow soil at the WUA, the in-place density targeted during construction will be 88.3 (pcf), which corresponds to 85% of MDD of the WUA soil.

3.2.4 Gamma Cap Location

The test gamma cap will be constructed in the former Bannock Paving Area (BPA). This area has been chosen due to the depth of the slag present as well as the very flat surface at that location, which simplifies construction and facilitates consistency in the gamma radiation field measurements. Soil borings advanced during the SRI indicate that slag depth ranges from a few feet to up to 10feet in the BPA. Based on the SRI boring logs, the selected location of the trial plot overlies a slag depth of approximately 6 feet (see SRI soil boring SB004 on Figure 3-1

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located immediately west of the test gamma cap location), which exceeds the modeled infinite thickness of 5 feet. The selected location is also far enough from the slag pile to minimize gamma shine impacts on gamma measurements during the test cap evaluation. The location of the cap within the BPA is presented in Figure 3-1.

3.3 TEST GAMMA CAP CONSTRUCTION METHODS

3.3.1 Cap Soil Placement and Compaction

It is necessary to limit compaction of the soil in order to provide a soil structure suitable for vegetation establishment. For a silty soil, a soil density less than 87.4 pcf (approximately 84% of MDD for the WUA soil) is ideal for root establishment while a soil density greater than 103 pcf (approximately MDD of WUA soil) is restrictive to root growth (http://soils.usda.gov/sqi/assessment/files/bulk_density_sq_physical_indicator_sheet.pdf). Therefore, to limit the amount of compaction, the soil will be placed in 8-inch lifts and spread and lightly compacted with up to three passes of a tracked dozer. It is anticipated that two 8-inch lifts will be sufficient to produce a minimum cap thickness of 12 inches at a density of 85% MDD.

3.3.2 Gamma Cap Construction Quality Control

Quality control testing will be performed on the constructed gamma cap trial plot to collect data regarding cap thickness and compaction. The quality control tests and frequencies are summarized in Table 3.1.

Table 3.1 - Summary of Gamma Cap Quality Control Testing

Parameter	Quality Control Testing	Frequency	Target Value	Tolerance
Soil compaction	In place density and moisture content	5 tests per lift	85% MDD	±3%
			OMC	±3%
Cap thickness	GPS Survey	Pre and post cap survey at 5 foot by 5 foot grid	14-inches	±2 inches

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3.4 DEMONSTRATION GAMMA MEASUREMENTS

3.4.1 Selection of Measurement Methods

The exposure rate measurements will be made using a GE Energy Model RSS-131 HPIC, or equivalent. The HPIC measures exposure rates directly and is considered a primary standard by the National Institute of Standards and Technology, when calibrated. It is highly stable, relatively energy independent, and serves as an excellent tool to calibrate other survey equipment to measure exposure rates.

3.4.2 Demonstration Exposure Rate

The distribution and frequency of demonstration exposure rate measurements are described in Section 4.4 and shown on Figure 3-1. The purpose of the exposure rate measurements is to directly assess compliance with the exposure rate of 17.4 μR/hr is the risk equivalent of the radium-226 cleanup level of 3.8 pCi/g. In summary, exposure rate measurements will be made at 1 m (3.3 feet) above the surface of the test cover on a 5 meter (m) grid, using an HPIC.

FMC

GAMMA CAP WORK PLAN

FIGURE 3-1

LOCATION OF
GAMMA GAP TRIAL PLOT
FORMER BANNOCK PAVING AREA

DATE: 11 June 2013

FILE: I:\projects\FMCIdaho\FMC_GammaStudy\FIGURES\Fig 3-4_FMC_Loc of Gamma Gap Trial Plot_May2013.mxd

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4.0 QUALITY ASSURANCE PROJECT PLAN & FIELD SAMPLING PLAN

4.1 INTRODUCTION

This section presents the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP) for the gamma cap performance evaluation and includes:

- Project team and project organization
- Data Quality Objectives (DQOs)
- Sampling/measurement procedures
- Equipment calibration procedures and frequencies
- Data reduction, reporting, verification, and validation
- Equipment preventative maintenance procedures
- Performance audits and corrective actions

4.2 PROJECT TEAM AND ORGANIZATION

The overall organizational structure and key personnel for the Gamma Cap Performance Evaluation and responsibility and authority of each team member is presented below.

4.2.1 EPA Remedial Project Manager

The EPA is the lead agency governing the remediation of the FMC OU. The EPA issued the IROD and UAO, and is responsible for approving all plans and reports related to implementing the Selected Remedy, including the Gamma Cap Performance Evaluation. The EPA Remedial Project Manager is Mr. Kevin Rochlin.

4.2.2 FMC Project Coordinator

As the responsible party, FMC is implementing the Selected Remedy in accordance with the UAO. FMC has overall responsibility for procuring consultants and contractors to perform the work, budgeting and securing the necessary funds, and assuring that the requirements of the UAO are met. The FMC Project Coordinator is Ms. Barbara Ritchie.

4.2.3 MWH Project Director

Mr. Marc Bowman is the MWH Americas, Inc. (MWH) Project Director and main point of contact for MWH, the Supervising Contractor. Mr. Bowman was the MWH Project Manager for the FMC Plant OU SRI/SFS and will have overall responsibility for successful completion of the RD and the Gamma Cap Performance Evaluation. He will be responsible for the contractual commitments and for ensuring that the necessary resources are dedicated to the project, will define/clarify the scope of work and objectives for each major activity, and will assure the

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technical, budget, and schedule requirements are met. Mr. Bowman, along with the RD Manager, will be responsible for coordinating with the necessary agencies and authorities to identify any permit requirements associated with implementation of the remedy.

4.2.4 MWH RD Manager

Mr. Rob Hartman is the MWH RD Manager and will be responsible for day-to-day technical elements of the test Gamma Cap design, installation, and monitoring as well as overall technical responsibility for the RD. Mr. Hartman has served as a technical lead on the FMC Plant OU SFS and has extensive knowledge of the FMC Plant OU. Mr. Hartman, along with the MWH Project Director, will be responsible for coordinating with the necessary agencies and authorities to identify any permit requirements associated with implementation of the remedy.

4.2.5 MWH Engineering Manager

Mr. Chad Tomlinson will serve as the MWH Engineering Manager and serve as the primary design interface to the MWH Project Director and the RD Manager. He will be responsible for coordinating the necessary resources to accomplish the design of the various elements and to complete the test Gamma Cap on schedule as well as providing construction quality assurance. Mr. Tomlinson is a registered professional (civil) engineer (registered PE in Idaho) with a technical specialty in geotechnical engineering and served as the primary engineer during the FMC Plant OU SFS.

4.2.6 KW Construction Quality Control Manager

Mr. Mark Smith will serve as the construction quality control manager for KASE/Warbonnet, Inc. (KW, the test Gamma Cap construction contractor). He will be responsible for providing the resources necessary to construct the test gamma cap, for development of the construction quality control procedures, and ensuring that the test gamma cap is constructed per the design specifications.

4.2.7 ERG Health Physicist

Mr. Mike Schierman of ERG, Inc. will serve as the health physicist for the Gamma Cap Performance Evaluation. He or his designee will be responsible for collecting field measurements and interpreting data.

4.2.8 Health and Safety Manager

Mr. Mark Smith of KW will serve as the project Health and Safety Manager (HSM) and have overall responsibility for implementation of the Site Health and Safety Plan. The HSM is responsible for monitoring and assessing hazardous/unsafe conditions, developing measures to assure personnel safety, maintaining the emergency response organization and equipment,

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performing job planning safety analyses (JPSAs) on job tasks, and training employees commensurate with their job responsibilities. The HSM is also responsible to ensure that unsafe actions or conditions are corrected in a timely manner.

4.3 DATA QUALITY OBJECTIVES (DQOs)

4.3.1 Data Types

As stated in Section 2.0, the primary gamma cap performance evaluation objective is to validate that a native soil cap (gamma cap) of a nominal one-foot thickness, when properly constructed, will shield gamma radiation from fill materials at the FMC Plant Site such that the incremental cancer risk RAO will be met. The secondary gamma cap performance evaluation objectives are to demonstrate: 1) achievable procedures for the construction of a native soil gamma cap of one-foot nominal thickness; and 2) the construction quality control/quality assurance methods for the construction of a native soil gamma cap of one-foot nominal thickness. Therefore, there are two types of data to be collected:

1. Gamma measurements to validate the primary objective; and
2. Construction quality control measures to demonstrate that the secondary objectives are met.

The DQOs for the test gamma cap performance evaluation are presented in Table 4.1.

4.3.2 Measurement and Data Acquisition

Exposure Rate Measurements

Field measurements will be made to both validate the model of the selected test cap and determine compliance with the PRG. The model of the selected test cap is 1,300 cm wide and long, 30.48 cm thick, with a density of 1.4 g/cm^3; and covers a homogenous source of slag with a radius and thickness of 850 and 152.4 cm, respectively. Field personnel will make exposure rate measurements with an HPIC.

Soil Construction Quality Control Measurements

Quality control measurements of the trial plot will consist of the following:

- Borrow material density and moisture content
- In-place density and moisture content by use of a nuclear density gauge.
- Cap thickness by use of a GPS survey

Moisture-density testing per ASTM D698 will be conducted on samples collected (at a rate 1 sample per 500 ft^3) from the borrow area used for construction of the soils covers. The results of the borrow testing will be used as a reference for the nuclear density testing. The nuclear density

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gauges will provide an approximation of the relative wet density and therefore moisture content of the in-place capping soil.

The GPS survey will utilize a Real Time Kinetic (RTK) method. The RTK GPS survey has an approximate horizontal and vertical accuracy of ± 20 millimeters (mm, about 0.75 inches) and ±40 mm (1.5-inches), respectively. The RTK survey involves the use of two GPS receivers (stationary base and Rover). The stationary base is placed on a known reference point and transmits measurement or correction information over a radio link to the Rover receiver that is used for positioning. The location and topographical survey SOP (SOP-3) is included in Appendix C.

4.4 SAMPLING/MEASUREMENT PROCEDURES

4.4.1 Gamma Measurement Procedures

Exposure rate measurements will be made at 1 m (3.3 feet) above the surface. This is the typical measurement height for the HPIC as the gamma exposure rate is defined at 1 m. One meter was also the measurement height used for all HPIC measurements during the SRI. The HPIC exposure rate measurements on the cover surface will be spaced on a 5 meter (m) grid. Measurements will be made at each location at six second intervals (ten per minute) for about two minutes. The average of the approximately 20 measurements will be reported for each location. Measurements will be duplicated at ten percent of the locations. The determination of the repeatability and accuracies of the measurements is addressed in Table 4.1. The HPIC Standard Operating Procedure (SOP-7) is included in Appendix C.

Maps depicting the exposure rates as isocontours, or equivalent, will be produced using ArcGis. The maps will be evaluated for validation of the model (i.e., infinite length of soil cover and compliance with the future outdoor worker radium-226 PRG.

4.4.2 Soil Construction Quality Control Measurement Procedures

Nuclear density measurements will be collected at a rate of 5 measurements per layer and will be collected from more or less a grid pattern. The measurements will be conducted in accordance with ASTM D6938-10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods. The densities obtained from the nuclear density gauge will be wet densities. These wet densities will be compared to the lab standard Proctor test (ASTM D698) collected from the borrow material.

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4.5 EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCY

4.5.1 High Pressure Ionization Chamber Calibration Procedures and Frequency

The HPIC will be used only under current calibration performed by Reuter Stokes. Current calibration certificates will be maintained with the instruments. Daily functions function checks will be performed on the HPIC in accordance with SOP-8 (Function Check of Equipment) before and after use. SOP-8 is included in Appendix C.

4.5.2 Soil Measurement Calibration Procedures and Frequency

The nuclear density gauge will be calibrated per ASTM D7013 (Standard Guide for Calibration Facility Setup for Nuclear Surface Gauges) prior to beginning each day's work, at the start of a new shift, or when discrepancies in measurements warrant additional calibration.

4.6 INVESTIGATION-DERIVED WASTE MANAGEMENT

Wastes generated during the gamma cap performance evaluation field work will be managed per the Investigation-Derived Waste SOP (SOP-4) that is included in Appendix C.

4.7 EQUIPMENT DECONTAMINATION

Equipment decontamination during the gamma cap performance evaluation field work will be managed per the Equipment Decontamination SOP (SOP-2) that is included in Appendix C.

4.8 PERSONNEL TRAINING

All personnel directly involved with the gamma cap performance evaluation will be provided with a copy of this Plan. Personnel will be trained in the requirements specified herein and provided ample time to read and become familiar with these requirements prior to beginning data collection activities.

4.9 SITE ACCESS AND CLEARANCE

Site access and clearance to the FMC Plant Site during the gamma cap performance evaluation will be managed per the Site Access and Clearance SOP (SOP-1) that is included in Appendix C.

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5.0 DATA REDUCTION, REVIEW AND REPORTING

5.1 DATA REDUCTION

All data for the Gamma Cap Performance Evaluation will be collected in the field. Field data will be used as reported from properly calibrated, direct-reading instruments.

5.2 DATA REVIEW, PERFORMANCE AUDITS AND CORRECTIVE ACTIONS

Prior to use, the MWH RD Manager or designee will review and assess the quality of field data. The data will be reviewed to assess whether the procedures specified in this Work Plan and QAPP were followed and to identify inconsistencies and/or anomalous values. Any inconsistencies will be resolved immediately, if possible, by seeking clarification from those personnel responsible for data collection. At a minimum, the information contained in field logs/notes, field-sampling forms, instrument outputs, as applicable, will be included in the review process. All changes or corrections to this field documentation will also be reviewed. A narrative will be prepared that describes any deviations from the procedures, explains any qualifications regarding the data quality, and describes any significant problem identified during the review process.

As the test gamma cap construction is expected to be completed within 2 to 5 days, construction quality control measurements will be field audited at least once during the construction period. As the gamma measurements on the test gamma cap are expected to be completed within 2 to 3 days, the gamma measurements will be field audited at least once during the construction period.

5.3 DOCUMENTATION AND REPORTING

All data collected in direct support of this gamma cap performance evaluation will be retained by FMC and/or its contractors consistent with the records retention requirements under the UAO. All data collected in direct support of this gamma cap performance evaluation will be reported to EPA in a report entitled *Gamma Cap Performance Evaluation Report* to be provided within 45 days of completion of the field work.

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6.0 HEALTH AND SAFETY PLAN

The FMC Plant OU is covered by the *Site-Wide Health and Safety Plan* (*SWHASP*, FMC, 2013). The *SWHASP* provides the Site health and safety organization, specific Site hazards, Site controls, Site evacuation procedures, Site PPE requirements, general health and safety procedures, and emergency procedures. In addition, the SWHASP requires that all Contractors working on the Site will develop their own action-specific Health and Safety Plan (HASP) which will incorporate the general requirements specified in the *SWHASP*. Each Contractor's action-specific HASPs must provide specific health and safety requirements that are pertinent to the anticipated activities during that action.

Per the requirements of UAO Section IX, Paragraph 30. a., FMC will submit the most recent version of the *SWHASP* under a separate transmittal. Copies of the *SWHASP* and all Contractor action-specific HASPs will be maintained on Site during actions performed under this Work Plan.

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7.0 DELIVERABLES AND SCHEDULE

In addition to this Plan and the *SWHASP* (as described in Section 6.0), a report entitled *Gamma Cap Performance Evaluation Report* will be provided within 45 days of completion of the field work.

The overall gamma cap performance evaluation project schedule is as follows:

Project Activity	**Schedule** [1]
Submittal of the *Site-Wide Health and Safety Plan*	45 days after EPA approval of Supervising Contractor (per UAO Appendix C).
Submittal of *Gamma Cap Performance Evaluation Work Plan*	60 days after effective date of the UAO (per UAO Appendix C).
Begin construction of test gamma cap	10 days after final approval of the *Gamma Cap Performance Evaluation Work Plan.*
Complete test gamma cap field measurements	10 days after initiation of construction of the test gamma cap.
Submittal of the *Gamma Cap Performance Evaluation Report*	45 days after completion of the test gamma cap field measurements.

[1] Note that "days" as provided in this schedule are "calendar days".

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8.0 REFERENCES

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APPENDIX A

Gamma Measurements for the Western Undeveloped Area and ProUCL Input and Output Files for Calculation of 95 UCL Background Gamma Dose Rate

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Gamma Measurements for Western Undeveloped Areas Input Data Set for Background 95 UCL		
Location ID	**GammaExposure**	**D_GammaExposure**
1	14.4	1
2	13.7	1
3	14.2	1
4	13.7	1
5	14.3	1
6	14.3	1
7	14.6	1
9	13.5	1
10	14.1	1
11	13.9	1
12	13.6	1
13	14	1
14	13.7	1
15	14.5	1
16	14.5	1
17	14.1	1
18	14	1
19	14	1
20	13.9	1
21	14.1	1
22	14.4	1
23	14.5	1
24	14.8	1
25	15.5	1
26	14.3	1
27	14.3	1
28	13.8	1
29	14.6	1
30	14.4	1
31	14.4	1
32	14	1
33	15.2	1
35	14.5	1
36	14.7	1
37	15.2	1
38	15.6	1
39	15.6	1
40	15.4	1
41	13.8	1
42	14.4	1
44	15	1

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Gamma Measurements for Western Undeveloped Areas Input Data Set for Background 95 UCL		
45	14.1	1
46	13.5	1
47	14.4	1
48	14.1	1
49	14.7	1
50	14.1	1
51	14.8	1
53	14.8	1
54	14.4	1
55	14.5	1
56	14.3	1
57	15.1	1
58	15.6	1
60	15.5	1
62	14.4	1
63	13.7	1
64	14	1
65	14	1
66	14.4	1
67	14.8	1
68	15.3	1
69	16.3	1
71	14.6	1
72	13.7	1
73	13.8	1
74	14	1
77	15.2	1
78	13.8	1
79	14	1
82	15.5	1
83	14.4	1
86	14.1	1
87	15.1	1
89	14.2	1
90	14.6	1
91	14.5	1
92	14.6	1
93	14.2	1
94	14.4	1
95	14.9	1
96	14.4	1
97	14.8	1

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1	**General UCL Statistics for Full Data Sets**			
2	**User Selected Options**			
3	From File	C:\EMF\Gamma Cap Demonstration\WUA Gamma Exposure - ProUCL Input.xls.wst		
4	Full Precision	OFF		
5	Confidence Coefficient	95%		
6	Number of Bootstrap Operations	2000		
7				
8				
9	**GammaExposure**			
10				
11	**General Statistics**			
12	Number of Valid Observations	83	Number of Distinct Observations	23
13				
14	**Raw Statistics**		**Log-transformed Statistics**	
15	Minimum	13.5	Minimum of Log Data	2.603
16	Maximum	16.3	Maximum of Log Data	2.791
17	Mean	14.45	Mean of log Data	2.67
18	Geometric Mean	14.44	SD of log Data	0.039
19	Median	14.4		
20	SD	0.57		
21	Std. Error of Mean	0.0626		
22	Coefficient of Variation	0.0395		
23	Skewness	0.772		
24				
25	**Relevant UCL Statistics**			
26	**Normal Distribution Test**		**Lognormal Distribution Test**	
27	Lilliefors Test Statistic	0.126	Lilliefors Test Statistic	0.118
28	Lilliefors Critical Value	0.0973	Lilliefors Critical Value	0.0973
29	**Data not Normal at 5% Significance Level**		**Data not Lognormal at 5% Significance Level**	
30				
31	**Assuming Normal Distribution**		**Assuming Lognormal Distribution**	
32	95% Student's-t UCL	14.55	95% H-UCL	N/A
33	**95% UCLs (Adjusted for Skewness)**		95% Chebyshev (MVUE) UCL	14.72
34	95% Adjusted-CLT UCL (Chen-1995)	14.56	97.5% Chebyshev (MVUE) UCL	14.83
35	95% Modified-t UCL (Johnson-1978)	14.55	99% Chebyshev (MVUE) UCL	15.06
36				
37	**Gamma Distribution Test**		**Data Distribution**	
38	k star (bias corrected)	637.4	**Data do not follow a Discernable Distribution (0.05)**	
39	Theta Star	0.0227		
40	MLE of Mean	14.45		
41	MLE of Standard Deviation	0.572		
42	nu star	105806		
43	Approximate Chi Square Value (.05)	105050	**Nonparametric Statistics**	
44	Adjusted Level of Significance	0.0471	95% CLT UCL	14.55
45	Adjusted Chi Square Value	105037	95% Jackknife UCL	14.55
46			95% Standard Bootstrap UCL	14.55
47	Anderson-Darling Test Statistic	1.145	95% Bootstrap-t UCL	14.56
48	Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL	14.55
49	Kolmogorov-Smirnov Test Statistic	0.12	95% Percentile Bootstrap UCL	14.56
50	Kolmogorov-Smirnov 5% Critical Value	0.0977	95% BCA Bootstrap UCL	14.56
51	**Data not Gamma Distributed at 5% Significance Level**		95% Chebyshev(Mean, Sd) UCL	14.72
52			97.5% Chebyshev(Mean, Sd) UCL	14.84
53	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	15.07
54	95% Approximate Gamma UCL (Use when n >= 40)	14.55		
55	95% Adjusted Gamma UCL (Use when n < 40)	14.55		
56				
57	**Potential UCL to Use**		Use 95% Student's-t UCL	14.55
58			or 95% Modified-t UCL	14.55
59				
60	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
61	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
62	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			

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Table 2-2. Exposure Rates in Western Undeveloped Area
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				Exposure Rate (µR/h)				
Location ID	**Date**	**Total Time (min)**	**No. of Points**	**Mean**	**Min**	**Max**	**Std Dev**	**PIC Serial Number**
1	6/15/2007	20	120	14.4	13.4	16	0.4	L-2079
2	6/15/2007	20	120	13.7	12.2	15.1	0.5	K-6905
3	6/15/2007	20	120	14.2	15.8	13.1	0.5	L-2079
4	6/15/2007	20	120	13.7	12.8	14.9	0.4	K-6905
5	6/15/2007	20	120	14.3	13.2	15.6	0.5	L-2079
6	6/15/2007	20	120	14.3	11.9	17.7	0.9	K-6905
7	6/15/2007	20	120	14.6	12.9	16.3	0.5	L-2079
8	6/15/2007	20	120	26.9	24.9	36.0	1.3	K-6905
9	6/15/2007	20	120	13.5	12.1	15.3	0.5	K-6905
10	6/15/2007	20	120	14.1	12.8	15.5	0.5	L-2079
11	6/15/2007	20	120	13.9	12.7	15.8	0.5	L-2079
12	6/15/2007	20	120	13.6	12.5	14.8	0.5	K-6905
13	6/15/2007	20	120	14	12.5	15.7	0.5	L-2079
14	6/15/2007	20	120	13.7	12.6	14.9	0.4	K-6905
15	6/15/2007	20	120	14.5	13.1	16.7	0.6	L-2079
16	6/15/2007	20	120	14.5	13.0	19.9	0.8	K-6905
17	6/15/2007	20	120	14.1	13.0	16.3	0.5	K-6905
18	6/15/2007	20	120	14.0	12.8	15.8	0.5	L-2079
19	6/15/2007	20	120	14.0	12.4	15.5	0.5	K-6905
20	6/15/2007	20	120	13.9	23.7	15.2	0.5	L-2079
21	6/15/2007	20	120	14.1	13.1	15.5	0.5	L-2079
22	6/15/2007	20	120	14.4	13.1	16.1	0.5	K-6905
23	6/15/2007	20	120	14.5	13.0	16.1	0.5	L-2079
24	6/15/2007	20	120	14.8	13.7	16.0	0.5	K-6905
25	6/16/2007	20	120	15.5	13.9	18.4	0.8	K-6905
26	6/18/2007	20	120	14.3	16.1	12.9	0.5	L-2079
27	6/18/2007	20	120	14.3	13.1	15.8	0.5	L-2079
28	6/15/2007	20	120	13.8	12.2	15.6	0.5	L-2079
29	6/18/2007	20	120	14.6	13.1	22.5	0.9	L-2079
30	6/18/2007	20	120	14.4	13.0	15.6	0.4	L-2079
31	6/18/2007	20	120	14.4	12.6	16.1	0.6	L-2079
32	6/18/2007	20	120	14.0	12.6	15.6	0.4	L-2079
33	6/18/2007	20	120	15.2	13.8	17.4	0.5	L-2079
34	6/16/2007	20	120	51.1	13.9	16.8	0.5	L-2079
35	6/16/2007	21.5	128	14.5	11.8	16.6	0.6	L-2079
36	7/18/2007	20	120	14.7	13.6	17.3	0.6	K-6905
37	7/18/2007	20	120	15.2	13.8	18.1	0.8	K-6905
38	7/18/2007	20	120	15.6	14.1	17.1	0.6	K-6905
39	7/18/2007	20	120	15.6	14.4	18.4	0.7	K-6905
40	7/18/2007	20	120	15.4	13.8	18.0	0.7	K-6905
41	6/18/2007	20	120	13.8	12.8	15.1	0.5	L-2079
42	6/18/2007	20	120	14.4	13.2	15.6	0.5	L-2079

Measurements shaded in grey are anomalous in the WUA due to the presence of slag on the surface in the vicinity of the measurement.

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Table 2-2. Exposure Rates in Western Undeveloped Area
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				Exposure Rate (µR/h)				
Location ID	Date	Total Time (min)	No. of Points	Mean	Min	Max	Std Dev	PIC Serial Number
43	6/16/2007	20	120	16	14.5	19.3	0.9	K-6905
44	6/16/2007	20	120	15	13.8	18.1	0.8	K-6905
45	6/16/2007	20	120	14.1	10.0	16.0	NR	K-6905
46	6/16/2007	20	120	13.5	12.1	14.9	0.5	L-2079
47	6/16/2007	20	120	14.4	7.8	16.3	1.1	K-6905
48	6/16/2007	20	120	14.1	12.3	15.8	0.5	L-2079
49	6/16/2007	20	120	14.7	13.4	16.8	0.6	K-6905
50	6/16/2007	20	120	14.1	13.2	15.8	0.5	L-2079
51	6/16/2007	20	120	14.8	13.6	16.1	0.5	K-6905
52	6/16/2007	20	120	18.5	17.3	20.4	0.6	L-2079
53	6/16/2007	20	120	14.8	12.8	20.6	1.1	K-6905
54	6/16/2007	20	120	14.4	12.8	16.5	0.5	L-2079
55	6/16/2007	20	120	14.5	13.1	18.8	0.9	K-6905
56	6/16/2007	20	120	14.3	13.3	17.3	0.5	L-2079
57	6/16/2007	20	120	15.1	13.6	18.7	0.8	K-6905
58	6/16/2007	20	120	15.6	14.3	17.1	0.5	L-2079
59	6/16/2007	20	120	20	18.7	22	0.6	K-6905
60	6/16/2007	20	120	15.5	14.5	17.1	0.5	L-2079
61	6/16/2007	20	120	16.6	15.0	20.1	0.7	K-6905
62	6/13/2007	20	120	14.4	13.0	22.8	0.9	L-2079
63	6/13/2007	20	120	13.7	12.5	15.2	0.5	L-2079
64	6/13/2007	20	120	14	12.8	15.5	0.5	L-2079
65	6/13/2007	20	120	14	12.8	15.5	0.5	L-2079
66	6/13/2007	20	120	14.4	12.5	15.6	0.6	L-2079
67	6/13/2007	20	120	14.8	13.4	16.3	0.6	L-2079
68	6/13/2007	20	120	15.3	13.8	18	0.6	L-2079
69	6/13/2007	20	120	16.3	14.6	18.1	0.5	L-2079
70	6/13/2007	20	120	35.7	34.3	37.6	0.6	L-2079
71	6/13/2007	20	120	14.6	13.3	25.3	1.1	L-2079
72	6/13/2007	20	120	13.7	12.2	15.4	0.5	L-2079
73	6/13/2007	20.17	121	13.8	12.5	15.8	0.5	L-2079
74	6/13/2007	20	120	14	12.8	15.6	0.5	L-2079
75	6/13/2007	20	120	33.3	14	35.5	2.7	L-2079
76	6/13/2007	20	120	51.6	49.6	54.5	0.7	L-2079
77	6/14/2007	20	120	15.2	14.1	16.5	0.5	L-2079
78	6/14/2007	20	120	13.8	12.6	15.6	0.5	L-2079
79	6/14/2007	20	120	14	12.7	16.3	0.5	L-2079
80	6/14/2007	20	120	29.4	27.7	31.5	0.6	L-2079
81	6/14/2007	20	120	53	51.2	55.5	0.8	L-2079
82	6/14/2007	20	120	15.5	14.3	17	0.5	L-2079
83	6/14/2007	20	120	14.4	13	16.1	0.5	L-2079
84	6/13/2007	18.2	109	15.5	13.8	17.1	0.6	L-2079

Measurements shaded in grey are anomalous in the WUA due to the presence of slag on the surface in the vicinity of the measurement.

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Table 2-2. Exposure Rates in Western Undeveloped Area
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				Exposure Rate (μR/h)				
Location ID	Date	Total Time (min)	No. of Points	Mean	Min	Max	Std Dev	PIC Serial Number
85	6/13/2007	20	120	51.4	49.1	53.3	0.7	K-6905
86	6/14/2007	20	120	14.1	12.7	17.3	0.8	K-6905
87	6/13/2007	20	120	15.1	14.1	20.9	0.8	L-2079
88	6/13/2007	20	120	27	13.3	29.9	1.4	L-2079
89	6/14/2007	20	120	14.2	11.3	17	0.7	K-6905
90	6/14/2007	20	120	14.6	13.3	16.1	0.6	L-2079
91	6/14/2007	20	120	14.5	12.7	22.3	1.2	K-6905
92	6/14/2007	20	120	14.6	13.3	16.1	0.5	L-2079
93	6/14/2007	20	120	14.2	12.8	17.8	0.8	K-6905
94	6/14/2007	20	120	14.4	13.4	16.3	0.6	L-2079
95	6/14/2007	20	120	14.9	13.6	16.1	0.5	L-2079
96	6/14/2007	20	120	14.4	13	16.3	0.7	K-6905
97	6/14/2007	20	120	14.8	13.4	16.3	0.6	L-2079
98	6/14/2007	20	120	15.6	13.8	18.6	0.6	L-2079
99	6/14/2007	20	120	16.8	15.6	19.8	0.7	K-6905
100	6/14/2007	20	120	41.2	39.5	44.9	0.8	K-6905

Measurements shaded in grey are anomalous in the WUA due to the presence of slag on the surface in the vicinity of the measurement.

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APPENDIX B

Gamma Cap Model Report

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GAMMA CAP MODEL REPORT

1 TEST GAMMA CAP MODELING

The Los Alamos Monte Carlo N-Particle Transport Code (MCNPX) was used to estimate the response (probability of photon absorption per photon emitted) in a discrete volume of air and sodium iodide detector from gamma radiation emanating from the FMC slag[1]. The response was modeled using a series of geometries (variable radius and depth) to determine the effective infinite radius and depth of the slag, prior to predicting the shielding effectiveness of the soil cover. The density and thickness of the soil cover were then varied in additional model iterations.

1.1 MODEL DEVELOPMENT

For purposes of the model, the slag was configured as a cylinder, with a density of 1.9 grams per cubic centimeter (g/cm$^{3)}$ and composition of calcium silicate ($CaSiO_3$). The radionuclide source (radium-226 plus decay progeny in secular equilibrium) within the slag was assumed to be distributed homogeneously at a concentration of 30 picoCuries per gram (pCi/g), consisting of all primary photons with probabilities of decay exceeding 1 percent, as listed in Table B.1.

A detector volume was modeled at one meter above the surface of the slag and the resulting MCNPX output files were configured to tally the energy imparted per gram of air per photon emitted (in million electron volts per gram per photon: MeV/g/γ). The source geometry was modeled for radii of 100 to 700 centimeters (cm) in 100 cm intervals; and 750 to 950 cm in 50 cm intervals. The thickness of the source was varied for each radius, from 30.48 to 213.36 cm in 30.48 cm intervals. Note that 30.48 cm is equivalent to one foot. A minimum of 10,000,000 photons was modeled for each of these simulations, with the exceptions discussed below.

[1] It is assumed that modeling for gamma radiation emanation from slag is representative of other fill materials (i.e., ore and/or ore-derived process wastes) on the surface of RAs receiving gamma or ET caps. This assumption is reasonable as uranium-238 (and radium-226 in secular equilibrium) concentration in ore are typically around 27 pCi/g while uranium-238 (and radium-226 in secular equilibrium) concentrations in slag are typically around 30 pCi/g (MWH 2009).

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Table B.1 – Radium 226 and Decay Progeny Gamma Emissions

Isotope	Energy (MeV)	Decay Probability 100% Equilibrium
Ra-226	0.186211	0.0359
Pb-214	0.053228	0.012
	0.241997	0.0743
	0.295224	0.193
	0.351932	0.376
	0.78596	0.0107
Bi-214	0.609312	0.461
	0.665453	0.0146
	0.768356	0.0494
	0.806174	0.0122
	0.934061	0.0303
	1.120287	0.151
	1.15519	0.0163
	1.23811	0.0579
	1.28096	0.0143
	1.377669	0.04
	1.4015	0.0127
	1.40798	0.0215
	1.509228	0.0211
	1.66128	0.0115
	1.729595	0.0292
	1.764494	0.154
	1.84742	0.0211
	2.11855	0.0114
	2.20421	0.0508
	2.44786	0.0157
Pb-210	0.046539	0.0425
	Total	1.9404

Notes:

MeV = million electron volts

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1.2 DETERMINATION OF INFINITE RADIUS AND THICKNESS OF SLAG

The first iteration of simulations was performed to approximate the infinite radius and thickness of slag, with respect to the detector. The infinite radius and thickness are defined as those at which gamma emissions from the increasingly large (in terms of radius and thickness) source no longer yield a measurable increase in the response of the detector. Table B.2 lists the results, in million electron volts per gram of air per photon emitted (MeV/g/γ). Table B.3 lists the exposure rates converted from the results in Table B.2, using Equation B.1.

Viewing the data on a surface plot (see Figure B.1) indicates that the exposure rate reaches a sustained maximum at a source radius and thickness of approximately 850 cm (28 feet) and 152.4 cm (5 feet), respectively. These values approach that of an infinite radius and thickness. Note that (unlike an experimental or field setting where exposure rates are expected to remain constant for all values greater than the infinite source dimensions) the simulated results do not. Using MCNPX, it is expected and demonstrated that the calculated exposure rates begin to fall as a result of more photons being shielded by a larger volume of material, because Monte Carlo simulation results are calculated per photon emitted. Thus, the fraction of photons reaching the detector is increasingly reduced with increasing volumes.

Table B.2 – Simulation Results with Varying Source Depth and Radius (MeV/g/γ).

Source Radius (cm)	Source Thickness (cm)						
	30.48	60.96	91.44	121.92	152.4	182.88	213.36
100	4.72E-08	2.45E-08	1.63E-08	1.23E-08	9.96E-09	8.10E-09	6.79E-09
200	2.26E-08	1.21E-08	7.90E-09	5.99E-09	4.78E-09	4.06E-09	3.50E-09
300	1.21E-08	6.46E-09	4.44E-09	3.16E-09	2.68E-09	2.29E-09	1.89E-09
400	8.00E-09	4.09E-09	2.69E-09	2.05E-09	1.66E-09	1.30E-09	1.09E-09
500	5.31E-09	2.96E-09	2.06E-09	1.46E-09	1.16E-09	9.65E-10	8.18E-10
600	3.91E-09	2.11E-09	1.29E-09	1.04E-09	7.62E-10	6.26E-10	5.66E-10
700	3.02E-09	1.50E-09	9.52E-10	7.42E-10	5.65E-10	4.96E-10	4.52E-10
750	2.67E-09	1.33E-09	8.59E-10	6.30E-10	5.04E-10	4.16E-10	3.61E-10
800	2.34E-09	1.21E-09	8.39E-10	5.82E-10	4.94E-10	4.05E-10	3.60E-10
850	2.12E-09	9.92E-10	7.12E-10	5.00E-10	4.39E-10	3.65E-10	3.15E-10
900	1.82E-09	8.64E-10	5.70E-10	3.95E-10	3.36E-10	2.69E-10	2.30E-10
950	1.59E-09	7.81E-10	4.75E-10	3.52E-10	3.05E-10	2.45E-10	0.00E+0[a]

Notes:

[a]Value not obtained because source radius extended beyond the MCNPX maximum limit for the simulation.

cm = centimeter
g = gram
MeV/g/γ = million electron volts per gram of air per photon emitted

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Each simulated value was converted to an approximate exposure rate in micro Roentgens per hour (μR/hr) using the conversion formula (Equation 3.1):

$$\dot{X} = \frac{f d \pi r^2 \rho\, S_i \gamma_f C T}{E}$$

Where:

$\dot{X}$: Exposure rate (μR/hr)
f: simulated detector response, (MeV/g_{air}/γ_{em})
d: thickness of slag (cm)
γ_f: 1.94 γ/dis for radium-226 photon emission factor from Table B.1.
r: radius of slag (cm)
ρ: density of slag (1.9 g/cm^3)
S_i: concentration of radium-226 (31 pCi/g)
C: conversion factor (0.037 dis/s pCi)
T: conversion factor (3600 s/hr)
E: conversion factor (5.48E7 Mev/R g_{air})

Table B.3 - Simulation Results with Varying Source Thickness and Radius (μR/hr)

Source Radius (cm)	Source Thickness (cm)						
	30.48	60.96	91.44	121.92	152.4	182.88	213.36
100	12.55	13.03	12.97	13.13	13.25	12.93	12.64
200	24.06	25.83	25.22	25.47	25.40	25.90	26.05
300	28.89	30.92	31.86	30.22	32.08	32.91	31.59
400	34.04	34.80	34.31	34.84	35.35	33.14	32.53
500	35.31	39.34	41.00	38.94	38.71	38.50	38.06
600	37.40	40.36	36.92	39.76	36.48	35.94	37.94
700	39.34	39.03	37.21	38.68	36.80	38.76	41.26
750	39.99	39.65	38.56	37.68	37.71	37.37	37.83
800	39.86	41.14	42.83	39.61	42.05	41.36	42.87
850	40.82	38.13	41.05	38.44	42.22	42.08	42.43
900	39.16	37.23	36.85	34.05	36.21	34.73	34.68
950	38.08	37.51	34.22	33.81	36.61	35.21	0.00[a]

Notes:

[a]Value not obtained because source radius extended beyond the MCNPX maximum limit for the simulation.

cm = centimeter
μR/hr = microRoentgens per hour

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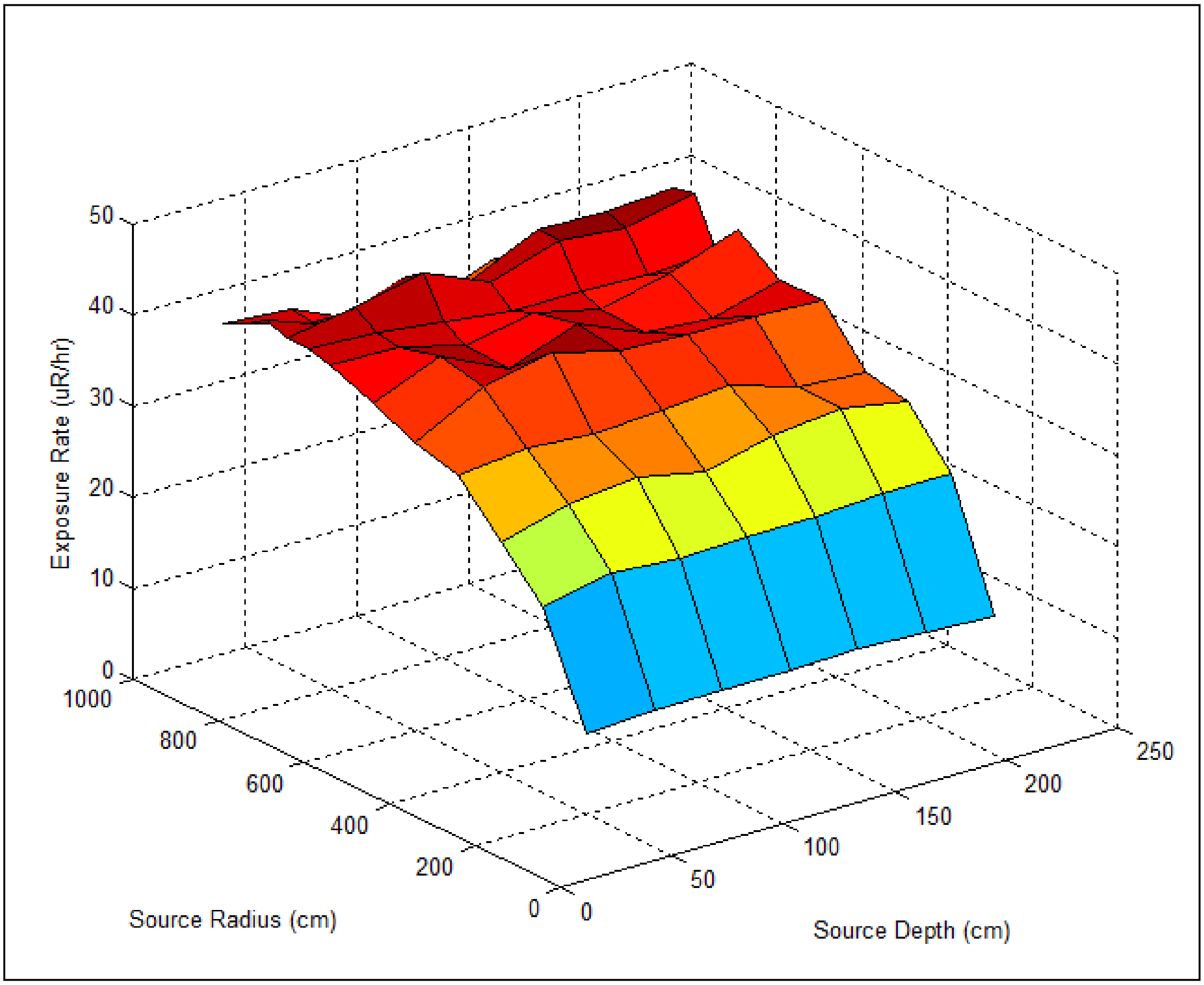
Figure B.1 - **Surface Plot of Simulated Results**



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1.3 GAMMA CAP MODEL SIMULATIONS

Additional simulations were performed with a soil cover (gamma cap) to evaluate the following:

- Effect of size and thickness of the gamma cap on photon attenuation;
- Shielding effects with varying cap thickness and density; and
- Validation of model simulations using a sodium iodide detector

Size and Thickness of Gamma Cap

The effects of a soil cover were evaluated, using the acquired infinite dimensions of the source within the slag. The soil cover was centered atop the slag; the configuration of the latter remained cylindrical, with a radius and thickness of 850 and 152.4 cm, respectively. The radium-226 source was unchanged. The soil was assumed to be dry sand, with an initial density of 1.6 g/cm^3. The soil cover was modeled as a parallelepiped with a fixed thickness of 30.48 cm and was varied in length and width proportionally from 100 to 1,800 cm in 50 cm increments. Note that in this configuration the horizontal extent of the slag exceeds that of the soil cover. The detector was maintained at 100 cm above the soil surface. The simulation results are listed in Table B.4 and the plot of exposure rates is depicted in Figure B.2.

The results in Figure B.2 indicate that the source has no edge impact on the detector at a minimum soil cover length and width of about 1,300 cm. The results also show that, at the simulated infinite thickness of slag, the soil cover effectively attenuates photon emissions from the source. The unshielded exposure rate of approximately 42 μR/hr decreases to 1.8 μR/hr with the 30.48 cm soil cover. Note that contributions from background are not considered.

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Table B.4 – Simulation Results of Soil Cover at Varying Length and Width

Soil Cover Width/Length (cm)	MeV/g/γ	μR/hr
100	3.78E-10	36.29
200	2.73E-10	26.27
300	1.91E-10	18.38
400	1.43E-10	13.78
500	9.86E-11	9.47
600	8.24E-11	7.92
700	7.02E-11	6.74
800	5.32E-11	5.11
900	3.80E-11	3.65
1,000	3.07E-11	2.95
1,100	2.47E-11	2.37
1,200	2.11E-11	2.03
1,300	1.92E-11	1.84
1,400	1.90E-11	1.82
1,500	1.88E-11	1.81
1,600	1.90E-11	1.82
1,700	1.88E-11	1.81
1,800	1.88E-11	1.81

Notes:

cm = centimeter
g = gram
MeV/g/γ = million electron volts per gram of air per photon emitted
μR/hr = microRoentgens per hour

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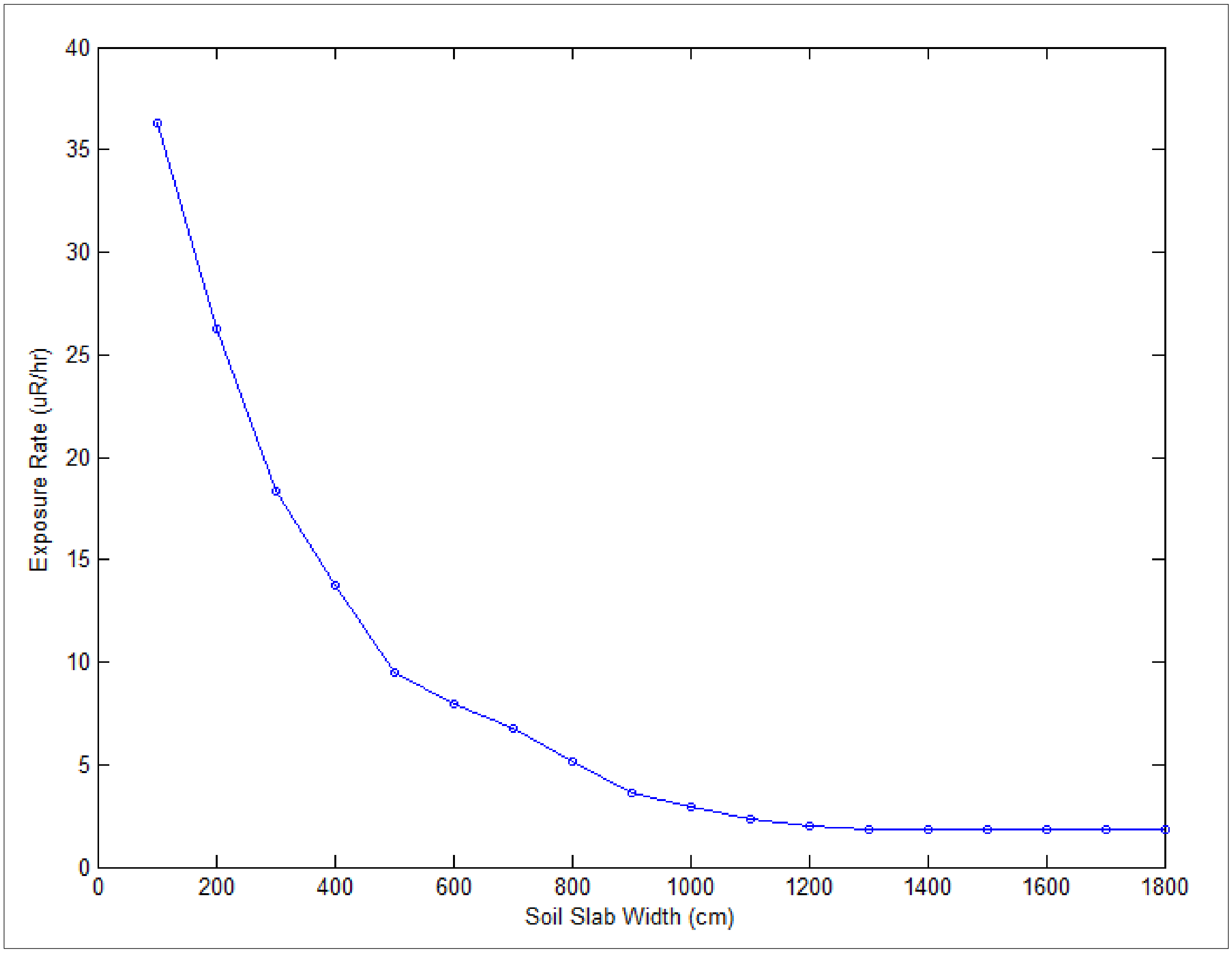
Figure B.2 – Simulation Results of Soil Cover with Varying Width



Shielding Effects with Varying Densities and Thicknesses of Soil Cover

Iterative simulations were performed to evaluate the shielding effects of soil density and thickness. The homogenous source of slag was maintained at a radius and thickness of 850 and 152.4 cm, respectively. The soil cover was maintained at a width and length of 1,300 cm and a depth of 30.48 cm, while the soil density was increased iteratively from 1.3 to 1.8 g/ cm^3 and 2 to 2.3 g/cm^3 in 0.1 g/cm^3 intervals. The simulation was repeated for soil depths of 25.4, and 35.56 cm for densities 1.3 g/cm^3 to 1.8 g/ cm^3 in 0.1 cm increments. For this simulation, 100,000,000 photons were tracked to minimize the variance of detection probability. Table B.5 lists the results in MeV/g/γ and μR/hr. The conversion of MeV/g/γ to μR/hr was performed using Equation B.1. The exposure rates as a function of the density are plotted in Figure B.3.

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Table B.5 - Simulation Results of 25.4 cm, 30.48 cm, and 35.56 cm of Soil Cover with Varying Density

Soil Density (g/cm^3)	10 in. (or 25.4 cm) Cover		12 in. (or 30.48 cm) Cover		14 in. (or 35.56 cm) Cover	
	MeV/g/γ	μR/hr	MeV/g/γ	μR/hr	MeV/g/γ	μR/hr
1.3	5.25E-11	5.04	3.68E-11	3.54	2.73E-11	2.62
1.4	**4.43E-11**	**4.25**	**2.98E-11**	**2.86**	**2.03E-11**	**1.95**
1.5	3.78E-11	3.63	2.83E-11	2.72	1.77E-11	1.70
1.6	3.39E-11	3.26	2.10E-11	2.02	1.59E-11	1.53
1.7	2.93E-11	2.81	1.85E-11	1.78	1.39E-11	1.34
1.8	2.64E-11	2.53	1.68E-11	1.61	1.12E-11	1.08
2	-	-	1.31E-11	1.26	-	-
2.1	-	-	1.13E-11	1.08	-	-
2.2	-	-	9.14E-12	0.88	-	-
2.3	-	-	7.44E-12	0.72	-	-
2.4	-	-	6.90E-12	0.66	-	-
2.5	-	-	5.72E-12	0.55	-	-

Notes:
Bolded values are for the density proposed for the gamma test cap.

cm = centimeter
g = gram
in. = inch
MeV/g/γ = million electron volts per gram of air per photon emitted
μR/hr = microRoentgens per hour

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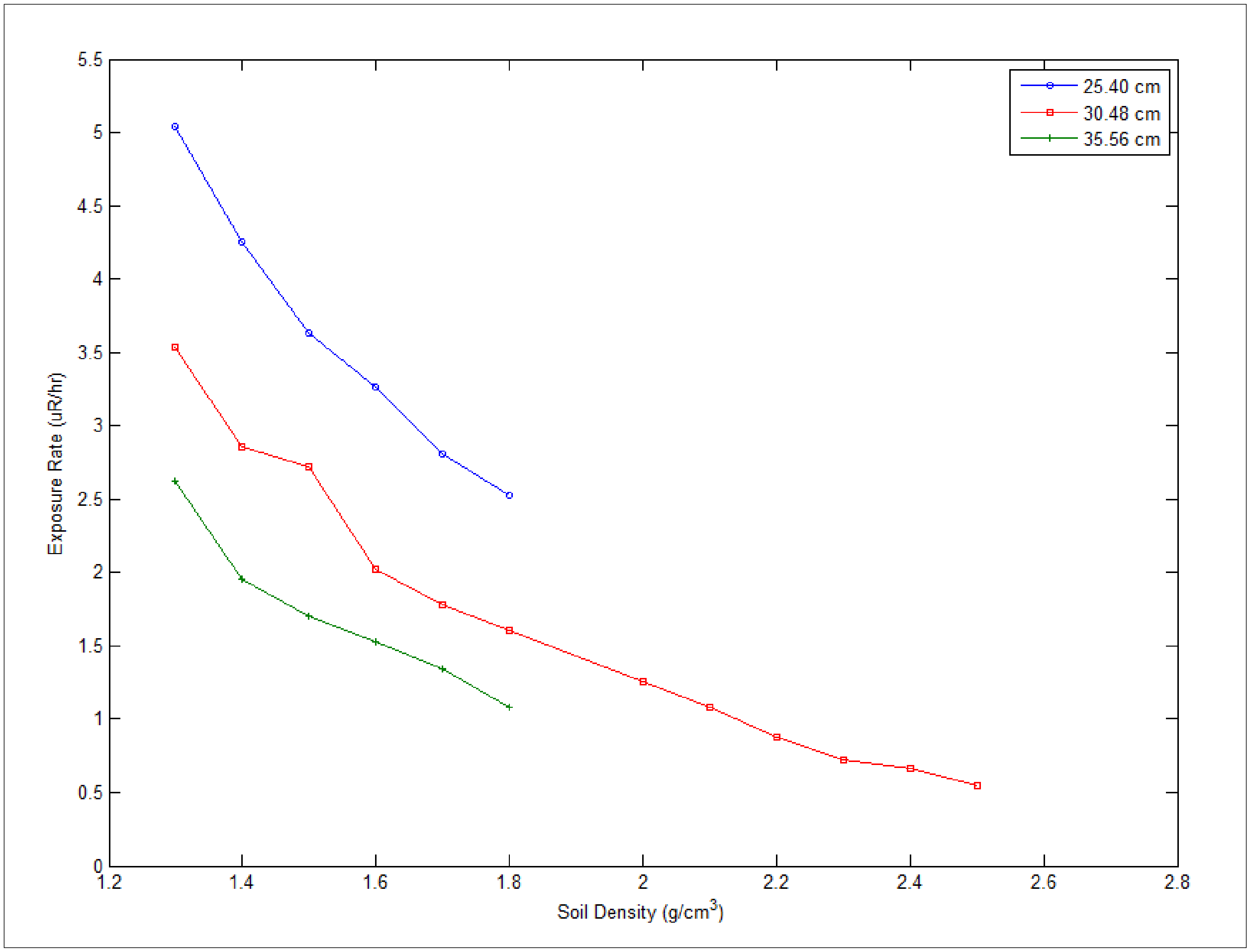
Figure B.3 - Simulation Results of 25.4 cm, 30.48 cm, and 35.56 cm of Soil Cover with Varying Density



<u>Validation of Model Simulations using Sodium Iodide Detector</u>

The last simulation was performed to compare the simulated results to experimental data. The simulation consisted of the slag (850 cm radius, 152.4 cm thick, homogeneously distributed radium-226 source) and soil cover (1,300 cm long, 30.48 cm thick; and a density of 1.4 g/cm^3). A 2-inch by 2-inch SID was modeled at 100 cm above the soil surface. The modeled detector consisted of an aluminum housing and cylindrical sodium iodide crystal, similar in composition and dimensions to the detectors used for the gamma walkover survey described in Section 1.2. A larger number of photons (1,000,000,000) were tracked to maximize the certainty of detections, because a relatively lower number of photons reach the crystal than in the case of air, with respect to the source concentration.

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The simulated results were tallied as the number of photons detected per photon emitted (γ_d/γ_{em}) within the crystal. Assuming a 100 percent photomultiplier tube efficiency, the detection efficiency is converted to counts per minute (cpm) using the conversion:

$$\dot{C} = \varepsilon_\gamma d \pi r^2 \rho\, S_i \gamma_f C t$$

Where:

$\dot{C}$: Simulated detector count rate in cpm
d: thickness of slag (cm)
ε_γ: Simulated detector response (γ_d/γ_{em})
r: radius of slag (cm)
d: thickness of slag (cm)
ρ: density of slag (1.9 g/cm^3)
S_i: concentration of radium-226 (31 pCi/g)
γ_f: photon emission factor for radium-226 from Table B.1 (1.94 γ/dis).
t: conversion factor (60 s/m)

The simulated results of the SID were compared to those for exposure as a correlation with the soil depth at 30.48 cm. The expected number of counts is 4,252 and the expected exposure for the modeled scenario (from previous simulations) is 2.86 μR/hr. This results in a simulated correlation of 1,486 cpm/μR/hr. The correlation reported in the SRI report as an average for two sodium detectors is 1,309 cpm/μR/hr. The correlation between the simulated gamma count and exposure rate is similar to that obtained experimentally at the site.

Note that there is a relatively higher variance in the scenario employing the sodium iodide detector than those observed for the volume of air, particularly with increasing soil densities. Photons in the latter scenario are not inhibited by an attenuating layer such as the aluminum housing and crystal in the sodium iodide detector.

1.4 MODEL CONCLUSIONS

The results indicate that a dry, 12-in. (30.48 cm) thick, sandy soil cover with a density of 1.4 g/cm^3 attenuates photon emissions from an infinitely thick source of slag to an exposure rate (2.86 μR/hr) that is similar to the RAO prescribed in the SFS (2.8 μR/hr above background). Actual conditions (addition of moisture and use of silty clay in lieu of sand) are expected to further attenuate the photons emitted from the slag; hence, the exposure rate will be slightly lower. Field measurements on the test cap will be used to both validate the model and demonstrate compliance with the RAO and the gamma exposure rate equivalent to the future outdoor worker radium-226 PRG prescribed in the IROD.

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APPENDIX C

STANDARD OPERATING PROCEDURES (SOPs)

SOP-1	Site Access and Clearance
SOP-2	Equipment Decontamination
SOP-3	Location and Topographical Survey
SOP-4	Investigation-Derived Wastes
SOP-7	HPIC Setup and Operation
SOP-8	HPIC Function Check and Equipment

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

This SOP has been revised from SOP No. 1 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

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1.0 INTRODUCTION

This standard operating procedure (SOP) defines minimum requirements that shall be fulfilled by all personnel in order to obtain site access and clearance(s) necessary to perform assigned tasks at FMC. It is the Contractor's responsibility to determine necessary clearances. Access and clearances required may include, but are not limited to, the following:

- Site access and clearance: FMC Project Manager
- Digging, Drilling, Excavation: FMC and/or FMC's contractor for FMC-owned property and Idaho Dig Line for off property locations (not anticipated).
- Public Road Closure: Idaho Department of Transportation
- Union Pacific Railroad where digging, drilling, or excavations are near the active Union Pacific Railroad tracks.

Close attention shall be paid to minimum waiting periods required before certain authorizations and clearances can be issued. Proper documentation shall be maintained at all times as evidence that authorization/clearance has been obtained. The minimum requirements for the above list are specified in this SOP. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

2.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional

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personnel may be involved as needed. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible for ensuring all personnel, including sub-contractors, have the applicable authorization(s) and clearance necessary to perform tasks as assigned. The RDRA Project Manager shall coordinate with other key project staff and FMC personnel to accomplish this task.

Field Team Leader (FTL): Responsible for ensuring access requirements are observed by field personnel at all times, preparing daily logs of field activities, and ensuring that documentation of all appropriate authorization(s) and clearance are at the work site at all times.

Field Technician (or other designated personnel): Assists the FTL with the implementation of field tasks.

3.0 ACCESS TO FMC-OWNED PROPERTY

The entrances to the FMC-owned property will normally be locked at all times. Entry onto the Site will be performed in accordance with the FMC Site-Wide Health and Safety Plan Section 5.1. RDRA contractors and subcontractors will have access to the gate key or code based upon approval and coordination with the RDRA Field Team Leader (FTL) and/or the RDRA Project Manager. All other contractors and/or visitors must obtain approval from FMC and schedule arrival and departure dates/time with FMC at the FMC Pocatello office.

All RDRA contractor and subcontractor employees performing work at the FMC Plant OU will be required to check in and check out with the FTL through the use of a sign-in sheet. A daily field log and sign in sheet will be kept at the work site by the FTL that will

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document all on site personnel and visitors. Persons not meeting the minimum standards as defined in SWHASP will not be allowed access by the FTL.

4.0 HOT WORK CLEARANCE

All cutting, welding, brazing, and other hot work will comply with all safety requirements of FMC SWHASP and the Safety, Fire Prevention and Health (AFOSH) Standard 91-5, OSHA 1910.252, and the National Fire Protection Agency (NFPA) codes.

Under this standard, personnel or contractors involved in RDRA activities that require welding, cutting, brazing, or other "hot work" shall fulfill the following requirements:

1. The RDRA contractor shall contact the FMC and the FTL prior to performing any hot work. This will allow the appropriate review and inspection of the work area prior to cutting, welding, brazing, or other "hot work". As the FMC Plant OU is expected to be fully decommissioned at the time of the RDRA field work, each case will be reviewed for potential hazards or other safety concerns. After such review, written approval (e.g., documented in the site log book) must be obtained from the FTL prior to any RDRA contractor performing hot work on the site.
2. Provide adequate number of portable fire extinguishers and place them as close to the work area as possible.

5.0 UTILITY CLEARANCE ON FMC-OWNED PROPERTY

Underground and aboveground utility clearance will be completed before subsurface investigations commence on FMC-owned property (including obtaining an excavation permit consistent with the requirements of Section 3.2.8 of the SWHASP) or off property (see Section 6 and 7 for requirements pertaining to investigations on lands not owned by FMC). The area within a 5-foot radius of each subsurface sampling location will be cleared using the following protocol:

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1. Review available facility utility maps provided by FMC and/or FMC's contractor, A&E Engineering.
2. Mark the proposed sampling locations and the utility lines in the immediate vicinity using a marker, stake, flags, or paint.
3. Verify proposed sampling locations with FMC plant or A&E employees with knowledge of the utilities to discuss undocumented utilities, potential obstructions, etc.
4. Scan the surface with a magnetic locator according to the manufacturer's directions to search for the presence of buried utilities and other obstructions.
5. Hand auger or push a probe to a depth of 4 to 5 feet below ground surface in areas where historic maps or historic knowledge of subsurface utilities are not available.
6. Overhead telephone and power lines shall also be taken into account when selecting drilling/excavation locations.
7. The RDRA contractor shall notify FMC and A&E in case of any suspicion or confirmation of damage to any underground utilities.

6.0 UTILITY CLEARANCE ON LANDS NOT OWNED BY FMC

Although subsurface investigation is not expected off FMC-owned property as part of the scope of this RDRA, the Idaho Dig Line provides one central location for contractors and the general public to call and notify multiple utility companies of intended excavation (off FMC-owned property). Information, contractor responsibilities, and an online tool to notify Idaho Dig Line of planned work can be found by calling 800-342-1585. Idaho Dig Line shall be notified at least 48 hours, but no more than seven (7) days, prior to drilling or excavation. Notices of drilling or excavation are good for 14 calendar days. Requests for a utility meeting with locators are scheduled through the Idaho Dig Line. If drilling or excavation on a single project lasts more than 14 days, Idaho Dig Line shall be notified prior to the deadline to update clearance permits. To obtain clearance for any drilling or excavation off FMC-owned property, MWH and/or its RDRA subcontractor shall provide Idaho Dig Line with the following information:

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- Company information including company name, address, and telephone number
- The name and telephone number of the caller
- Type of work to be accomplished including information regarding anticipated depth and information regarding horizontal or vertical boring
- Date of proposed work
- Precise location of the proposed drilling/excavation site. This shall be a detailed description including street address, street names and numbers, subdivision lot number if available, direction and distance relative to street or intersection (north, south, east, or west), and any other relevant information. If possible, the site shall be pre-marked with white paint, stakes, or flags
- Provide a location map if requested by Idaho Dig Line
- Marking instructions (e.g., portion of site to be cleared by Idaho Dig Line)
- Field personnel contact name and telephone number

If subsurface investigation is required off FMC-owned property, the RDRA contractor/excavator shall work with MWH to provide this information. MWH shall obtain a Location Request Number from the Idaho Dig Line representative. This is a number that references the caller with the details of the proposed excavation and is helpful when contacting a member utility or Idaho Dig Line for further assistance. MWH and the RDRA subcontractor shall possess this number at all times on job sites to prove compliance with state statutes.

After Idaho Dig Line and local utilities have marked the proposed drilling or excavation site, a minimum clearance of five feet will be maintained between a marked and unexposed underground facility and the cutting edge or point of any power-operated excavating or earth moving equipment. If excavation is required within five feet of any marking, the excavation shall be performed utilizing a hand auger or probe point to check for underground utilities. MWH or the subcontractor shall notify FMC and the Idaho Dig Line in case of any suspicion or confirmation of damage to the underground utilities.

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Underground utilities are marked with paint or pin flags with a color scheme representing different utilities. The way that these lines will be identified by the various utilities are defined by the following legend:

Red = Electric

Yellow = Oil and Gas

Orange = Communications including Cable TV, telephone and fiber optics.

Blue = Water

Green = Sewer

Pink = Temporary Survey Markings

White = Proposed Excavation

7.0 PUBLIC ROAD CLOSURE

Although not expected as part of the scope of this RDRA, the Idaho Department of Transportation (IDOT) requires road/lane closures for all work conducted on designated highways, or shoulder areas of designated highways, within the state of Idaho. This includes, but is not limited to, drilling and excavation and other work to be performed along roadways and shoulders. In such a case, it is the responsibility of MWH to contact IDOT for any authorizations. The following information must be submitted with the application:

- Applicant's name, address and phone
- Reason for permit
- Location of work site, including highway number, city, county, milepost or description
- Anticipated commencement and completion of construction/work
- Instructions for new utility installations
- A map of the work area if possible
- A diagram of the type of road closure signs required
- A name and address of the personnel who will close the lane/road

A performance bond may be required by IDOT prior to commencement of work on IDOT property.

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STANDARD OPERATING PROCEDURE 2

EQUIPMENT DECONTAMINATION

This SOP has been revised from SOP No. 3 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURES 2

EQUIPMENT DECONTAMINATION

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1.0 INTRODUCTION

Decontamination of drilling, sampling equipment, monitoring/inspection equipment and support vehicles at the FMC site is a necessary and critical aspect of environmental field investigations. Proper decontamination is a key element in reducing the potential for cross-contamination between samples from different locations, ensuring that samples are representative of the sampled materials, as well as health and safety issues associated with elemental phosphorus. Improper decontamination may result in costly re-collection and re-analysis of samples. All equipment used in the sampling process shall be properly decontaminated prior to the collection of each sample and after completion of sampling activities.

The procedures outlined in this standard operating procedure (SOP) shall be followed during decontamination of field equipment used in the sampling process, including drilling, soil/water sample collection, and monitoring/inspection activities. Any deviations from these procedures shall be noted in the field logbooks and approved by the RDRA Project Manager and the Quality Manager. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

Three major categories of field equipment, along with applicable decontamination methods for each, are discussed below.

2.0 DEFINITIONS

Brass Sleeve: Hollow, cylindrical sleeves made of brass and used as liners in split-spoon samplers for collection of undisturbed samples.

Auger Flight: An individual hollow-stem auger section, usually 5 feet in length.

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Continuous Core Barrel: 5-foot long steel barrels that can be joined together to allow continuous cores to be collected during a single run.

Drill Pipe: Hollow metal pipe used for drilling, through which soil and groundwater sampling devices can be advanced for sample collection.

Potable Water: A drilling quality water source that can be used for steam cleaning and decontamination water. This source should be sampled at the beginning of each field program to set baseline concentrations.

Distilled Water: Commercially available or laboratory-grade water that has been distilled. Each batch of distilled water should be analyzed to set baseline concentrations. The distilled water will be used as rinse water during the decontamination of tools, sampling equipment and other small items.

Hand Auger: A sampling tool consisting of a metal tube with two sharpened spiral wings at the tip.

Split-Spoon Sampler: A sampling tool consisting of a thick-walled steel tube with a removable head and drive shoe. The steel tube splits open lengthwise when the head and drive shoe are removed.

Scoop: A sampling hand tool consisting of a small shovel- or trowel-shaped blade.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

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RDRA Project Manager: Selects project-specific drilling and sampling methods, and associated decontamination procedures with input from other key project staff and other personnel that are responsible for project quality control.

Quality Manager: Performs project audits. Ensures project-specific data quality objectives are fulfilled.

SRI Field Team Leader (FTL) and/or Geologist, Hydrogeologist, or Engineer: Implements the field program and supervises other sampling personnel. Ensures that proper decontamination procedures are followed. Prepares daily logs of field activities.

Field Sampling Technician (or other designated personnel): Assists the FTL, geologist, hydrogeologist, or engineer in the implementation of tasks and is responsible for the decontamination of sampling equipment.

4.0 DECONTAMINATION PROCEDURES

A decontamination pad designed to collect the rinsate and any associated soil or chemicals will be established in a location at the FMC site. The decontamination pad will be constructed in an area designated by FMC and will be used for the duration of the field activities. The decontamination pad will be large enough to accommodate the drilling equipment components that come into contact with contaminated soils or groundwater that are present at the site. The rinsate collected from the decontamination pad and from other onsite decontamination activities will be stored in labeled containers until the proper disposal protocol is established pending waste characterization.

Soil boring drilling and soil sampling procedures require that decontaminated tools be employed in order to prevent cross-contamination. The decontamination procedures described below shall be followed to ensure that only uncontaminated materials will be introduced to the subsurface during drilling and sampling. For equipment and tools that have come into contact with contaminated soils or groundwater, the equipment

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decontamination process shall be undertaken before and after each use of the equipment and include washing. The flooring of the decontamination pad shall be impermeable to water and have a sump or low area to collect the rinsate to be transferred into the storage containers.

The precise location of the decontamination facility shall be determined based on such factors as ease of access for personnel and proximity to work site and rinsate storage or staging areas.

4.1 DRILLING AND LARGE EQUIPMENT

4.1.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment and support vehicles in areas of the Site in which there is a potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). This will include percussion hammer drill pipe, hollow-stem auger flights, drill rods for sampling, the drill rig, support vehicles and other equipment and tools that may come in contact with sampling equipment or that may have possible contamination.

- Wash the external surfaces and internal surfaces, as applicable, on equipment using water from an approved water source. If necessary, scrub using a phosphate-free detergent (e.g., Alconox™), or equivalent laboratory-grade detergent until all visible dirt, grime, grease, oil, loose paint, rust, etc., have been removed.
- Rinse with potable water.

4.1.1 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment, trenching equipment, construction equipment, and support

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vehicles in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). Note that this procedure will apply to equipment that comes into contact with native soils and/or slag on slag covered roads or surfaces. For example, trenching in the Western Undeveloped Area and/or construction of the test gamma cap will involve drilling, trenching, digging, or construction activities in areas where the large equipment will only contact native soils and slag on roads and/or construction surfaces.

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing tires and other surfaces that came into contact with native soils or slag.

4.2 SOIL AND GROUNDWATER SAMPLING/INSPECTION EQUIPMENT

4.2.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedure will be used to decontaminate sampling/inspection equipment such as split-spoon samplers; brass sleeves; continuous core barrels; scoops; hand augers; metal sampling pans; video equipment and other sampling/inspection equipment and tools that may come into contact with contaminated soils and/or groundwater.

- Wash and scrub equipment with phosphate-free, laboratory-grade detergent (e.g., Alconox™ or equivalent); steam cleaning may also be performed if possible.
- Double or Triple-rinse with potable water.
- Air dry.
- Store in clean plastic bag or designated casing.

Personnel involved in decontamination activities shall wear appropriate protective clothing as defined in the project-specific health and safety plan.

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4.2.2 In Areas with Potential Contact with Elemental Phosphorus

The following procedure will be used to decontaminate sampling/inspection equipment such video equipment and/or sampling equipment and tools that may come into contact with site materials contaminated with elemental phosphorus (P4). The only activity where potential P4 exposure is expected is while video surveying the storm sewers in RA-A. Special health and safety precautions for the storm sewer video survey include:

- Persons involved in the video survey of the RA-A storm sewers should read and be familiar with the hazards of P4 exposure as presented in Section 3.1.3 of the SWHASP. Note that the immediate area around the location where the storm sewer video survey is being performed shall be designated an *Exclusion Zone* as discussed in Section 6.1.1 of the SWHASP.
- Persons involved in the video survey of the RA-A storm sewers, performing decontamination, and within the *Exclusion Zone* shall don ***Modified Level C Protection for Potential Phosphorus Exposure*** as discussed in Section 7.3.3 of the SWHASP.

As the camera and wiring is removed from the storm sewers, the following decontamination procedures will be applied:

- Wash and scrub equipment with water as the camera and wiring is withdrawn from the sewer piping, taking care to only handle the cleaned portion of the equipment (while wearing the ***Modified Level C Protection for Potential Phosphorus Exposure***).
- Double or Triple-rinse with potable water.
- Capture all wash and rinse water in a metal container for later waste determination.
- Air dry the camera and wiring until completely dry. This will allow any remaining P4 to oxidize prior to stowage.

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4.2.3 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of sampling equipment including in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring).

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing surfaces that came into contact with native soils or slag.

4.3 GROUNDWATER MONITORING EQUIPMENT

The following procedure shall be used to decontaminate groundwater monitoring devices such as groundwater elevation meters and free product thickness meters. Spray bottles may be used to store and dispense distilled water.

- Wash equipment with laboratory-grade, phosphate-free detergent (e.g., Alconox™ or equivalent) and water, or steam clean.
- Triple-rinse with distilled water.
- Store in clean plastic bag or storage case.

5.0 PROCEDURE FOR OTHER WASTE DISPOSAL

While the decontamination Investigative Derived Waste (IDW) will be evaluated on a case-by-case basis, the general approach to be followed is detailed in SOP-7. Decontamination fluids (typically washwater) will be contained as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad or within the collection container). Washwater will then be containerized to await waste

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determination. Solids will also be containerized in a separate container to await waste determination.

6.0 REFERENCES

Environmental protection Agency, RCRA Ground-Water Monitoring: Draft Technical Guidance, November 1992. Page 7-17.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

This SOP has been revised from SOP No. 6 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

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1.0 INTRODUCTION

Surveying is the science of making the measurements necessary to determine the relative positions of points above, on, or beneath the surface of the earth, or to establish such points. This standard operating procedure (SOP) provides a description of the general types of surveys and requirements for performing these surveys. This SOP describes the applicability of the Global Positioning System (GPS) surveys, along with precision and accuracy required for each technique. This SOP is intended for the project leader to help develop work plans and manage resources. Note that in addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) while working on Site.

2.0 DEFINITIONS

Accuracy: Accuracy refers to the closeness between measurements and expectations or true values. The farther a measurement is from its expected value, the less accurate it is. Observations may be accurate but not precise if they are well distributed about the expected value, but are significantly disbursed from one another.

Accuracy is often referred to in terms of its order (i.e., first, second, or third order accuracy). The order of accuracy refers to the error of closure allowed; guidelines for each order of accuracy are as follows:

Order of Accuracy	Maximum Error
1st	1/25,000
2nd	1/10,000
3rd	1/5,000

Benchmarks: Monuments placed by surveyors to serve as permanent reference points. Benchmarks are elevation markers, and their location and elevation are precisely established and recorded on surveyors' level notes. They are set upon some permanent object to ensure they remain undisturbed.

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Global Positioning System (GPS): This system utilizes a network of overhead satellites orbiting the earth to locate objects and/or targets on the surface of the earth. Data from a minimum of three satellites is required to plot (by triangulation) the location of a certain point. Accuracy is dependent on the duration of data collection and the type of receiver/antenna used. All measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988.

Monuments: Physical objects that serve as landmarks for navigation. Classes of monuments include: natural, artificial, record, or legal. Examples of natural monuments are trees, large stones, or other substantial, naturally occurring objects in place before the survey was made. Artificial monuments can consist of iron pipe or bar driven into the ground, concrete or stone monument with a drill hole, cross, or metal plug marking an exact location (such as a corner). The standard for monumenting public-land surveys, as adopted by the Bureau of Land Management (BLM), is a post made of iron pipe filled with concrete. The lower end of the pipe is split and spread to form a base and the upper end is fitted with a brass cap with identifying marks. A record monument exists because of a reference in a deed or description (e.g., the gutter along a street). A legal monument is one that is controlling in the description (e.g., "to a concrete post").

Precision: Precision pertains to the distribution over a set of repeated observations of a random variable. It is a measure of the reproducibility of a result or measured value. Thus, if observations are closely clustered together, then the observations are said to have been obtained with high precision. Observations may be precise but not accurate if they are closely grouped about a value that is different from the expected or true value.

Station: A station is a 100-foot section of a measurement from a reference point such as a benchmark. For example, a stake placed 1,500 feet from a reference point is at station 15 and is labeled "15+00," and a stake placed 1,325 from a reference point is labeled "13+25."

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3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: The RDRA Project Manager has overall responsibility for establishing the specific technical requirements and coordinating the survey services for the project. The RDRA Project Manager shall rely on input from FMC personnel and other key project staff who may have more detailed knowledge of the technical requirements and who would be on site to oversee the surveying. To facilitate the management and administration of surveying services procured for a particular site, the RDRA Project Manager may delegate responsibility to the Field Team Leader (FTL) as the focal point for all matters involving surveying services.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Responsible for implementation of the actual field activities performed on site including the measurement of sampling locations and to daily check the accuracy of the GPS instrument. In addition, the FTL shall be responsible for scheduling and coordinating field activities, overseeing survey activities, and preparing daily logs of field activities.

Surveyor (Surveying Contractor): In the event a licensed land surveyor is needed, the surveyor will be responsible for assuring that all surveying field operations, office calculations, map preparation, and related surveying activities conform to established guidelines and the specific requirements of the surveying subcontract (including health and safety requirements). All surveying operations shall be performed by, or under the direction of, a State of Idaho Licensed (or Registered) Land Surveyor, who shall sign and seal all final drawings, maps, and reports submitted as deliverables.

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4.0 GUIDELINES

The following sections provide guidelines for the performance of several types of surveys and the precision and accuracy required for each. Emphasis is placed on the application of surveying techniques to environmental investigations.

4.1 PERFORMING SURVEYS

There are many types of surveys that can be performed. This SOP describes the survey that will potentially be used at the FMC site. The survey will be used to establish northing and easting measurements and an elevation (feet above mean sea level). A Sokkia Axis, Trimble GEO Explorer, Trimble Pathfinder GPS or similar unit will be used for mapping test pits, boreholes, PIC and other sampling locations as well as being used for determining the thickness of soil covers. The selected unit must have an accuracy of 1 meter or less and will be checked daily with a known elevation of a benchmark. If the accuracy is greater than 1 meter, than the type of location data will be evaluated as to whether a professional surveyor is required. All measurements will be referenced to a State Plane Coordinate System, North American datum 1983 and the North American Vertical Datum 1988.

Global Positioning System (GPS) Surveying: GPS is a ranging system from known positions of satellites in space to unknown positions on land, sea, and in air or space. GPS uses the triangulation from orbiting satellites to establish the location derived from the broadcast of a satellite signal. The GPS unit measures the distance using the travel time of radio signals. The GPS concept assumes that four or more satellites will be available at any location on earth 24 hours a day.

Establishing Control (Benchmark): Prior to initiating any type of survey, a control shall be established at the site. The control point will be a surveyed benchmark used as a daily check for the accuracy of the GPS unit. If a benchmark is not available at the site or if access is limited, a fixed monument may be established by a licensed surveyor.

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Licensed Surveyor: In the event that a licensed surveyor is required for increased accuracy a State of Idaho Licensed Surveyor will be used at FMC. In the State of Idaho, the Idaho State Government Department of Commerce, Division of Occupational and Professional Licensing, administers licensing and certification programs.

Based on the project requirements, monuments may be set at the site that can be used in future site-surveys as a control point. Care shall be taken when establishing new control points and elevations from other agencies' vertical control points to ensure that all the old control benchmarks are on the same datum or reference plane. The monument shall be stamped with the state planar coordinates and the elevation (feet above mean sea level) such that it shall serve as a reference point for additional surveys. This can save time in future survey work as the surveying contractor will not have to survey new locations from distant established control points.

4.2 REQUIRED ACCURACY AND PRECISION

The required survey accuracy and precision depends on the intended purpose of the survey work. Sampling locations are to be surveyed within 1 meter or less both horizontally and vertically. Higher accuracies may be required for boundary surveys, topographic surveys, etc. The following sections discuss accuracy and precision requirements for specific survey types.

Marking Sampling Locations: The sampling location will be marked in the field using a stake with the corresponding sample number in the event that the location is revisited for additional sampling or surveying.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE MANAGEMENT

This SOP has been revised from SOP No. 7 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT

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1.0 INTRODUCTION

Investigation-derived waste (IDW) may be generated during the field investigation activities conducted under the planned performance evaluation and data gap investigations at the FMC Plant Operable Unit during 2013. The National Contingency Plan (NCP), codified in 40 Code of Federal Regulations (CFR) 300, requires that IDW be handled to attain all the applicable or relevant and appropriate requirements (ARARs) to the extent practicable, considering the urgency of the situation. The purpose of this SOP is to present procedures to be followed in the management of IDW generated during these field activities.

Potential IDW that may be generated during field activities are solid wastes and may include (but are not limited to) the following media and waste types:

Fluids	Solids
Groundwater well development / purge	Soils and soil cuttings
Drilling mud	Plastic tarps or sheeting
Grout	Drill pipe and well casing/screen
Decontamination fluids and wastewater	Decontamination solids
	Disposable equipment (i.e., rope, bailers, sampling equipment, & other consumables)
	Spent personal protective equipment (PPE)
	Used containers, sample bottles
	Packaging materials

The above wastes may or may not be encountered, generated or managed while performing the 2013 field activities. However, all solid waste streams will be characterized to determine if they are hazardous wastes per 40 CFR § 262.11 for the purposes of handling and disposal. Guidance from this document shall be used as part of project planning to estimate total volumes of IDW likely to be generated during the anticipated 2013 field activities as well as how the IDW will be managed and disposed.

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2.0 DEFINITIONS

Area of Contamination (AOC) unit: The AOC unit concept is critical to the IDW management at a CERCLA investigation site. Although EPA has not promulgated a definition of an AOC unit, an AOC unit is generally an area within a CERCLA investigation site with similar characteristics with respect to contamination and the associated risks to human health and the environment. A CERCLA investigation site may contain one or more AOC units. AOC units for the FMC Plant Operable Unit, which may be different from the Remediation Units (RUs) as used in the *SRI Work Plan for the FMC Plant OU* and/or the Remediation Areas (RAs) used in the *SFS Report for the FMC Plant OU*, will be delineated based upon exiting information, information gathered during the SRI, and visual observation as well as consideration of IDW management.

Decontamination fluids: Any fluids, including aqueous wash water, solvents, and contaminants that are used or generated during decontamination procedures.

Decontamination solids: Any solids, including soils and soil cuttings, fill materials, and contaminants that are generated during decontamination procedures.

Grout: A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed as required.

Hazardous waste: A solid waste that meets the definition of a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Hazardous IDW: An investigation derived waste that is also a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Investigation-derived waste (IDW): Solid wastes, as defined in 40 CFR § 261.2, directly generated as result of performing the 2013 field activities at the FMC Plant OU.

Nonhazardous waste: A solid waste that does not meet the definition of a hazardous waste as defined in 40 CFR § 261.3 or is excluded from hazardous waste regulation per 40 CFR § 261.4(b).

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Soils and soil cuttings: Solid material generated from excavation or drilling processes. Soils may include native soils, fill materials, and/or other historical plant waste streams used as fill materials on the site.

Solid waste: Any waste stream (solid, liquid or containerized gas) that meets the definition of solid waste under RCRA as defined in 40 CFR § 261.2.

3.0 RESPONSIBILITIES

This section presents a brief definition of the field team roles and responsibilities for management of IDW generated while conducting the 2013 field activities. This list is not intended to be a comprehensive list as additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible to ensure that all field team members are properly trained per their responsibilities associated with IDW and that appropriate equipment and facilities are available for appropriate IDW management.

Field Team Leader (FTL): Implements the field program and supervises all field team members in the appropriate management of IDW. Ensures that only properly trained personnel are managing IDW on the site.

Environmental, Health and Safety (EHS) Officer: Assists the Field Team Leader in the supervision of all IDW management on site. The EHS officer shall be responsible for all IDW identification and characterization, on site disposal, off site shipment and disposal, waste accumulation, emergency response and contingency planning, IDW training, and IDW reporting and recordkeeping.

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Project Team Members: Ensure that they are properly trained prior to any IDW management as well as follow the appropriate IDW procedures and training.

4.0 REGULATORY BASIS AND GUIDANCE

IDW encountered, generated, or managed during the 2013 field activities may contain hazardous substances as defined by CERCLA. Some IDW may be hazardous wastes under RCRA while others may be regulated under other federal laws such as TSCA. These regulatory requirements may be applicable or relevant and appropriate requirements (ARARs) which impact how the IDW is managed. Note that hazardous wastes under RCRA and/or wastes regulated under TSCA are not expected to be encountered, generated, or managed as part of the 2013 field activities. However, waste determinations will be performed and documented on all waste streams.

4.1 EPA GUIDANCE ON IDW MANAGEMENT

The management of IDW generated during the 2013 field activities shall be in accordance with EPA Guidance "Management of Investigation-Derived Wastes During Site Inspections", May 1991 (EPA, 1991). This guidance is based upon EPA's strategy for managing IDW based upon the following concepts:

- The National Contingency Plan (NCP) directive that CERCLA site investigations (SI) comply with applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

- The Area of Contamination (AOC) unit concept.

The specific elements of EPA's guidance for IDW management are as follows:

- Characterizing IDW through the use of existing information (manifests, MSDSs, previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgement.

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- Delineating an AOC unit for leaving RCRA hazardous soil cuttings within the unit.

- Containerizing and disposing of RCRA hazardous groundwater, decontamination fluids, PPE, and disposable equipment at RCRA Subtitle C facilities.

- Leaving on-site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids preferably without containerization and testing.

In general, EPA does not recommend removal of wastes from sites, in particular, from those sites where IDW do not pose any immediate threat to human health or the environment. Actions taken during the 2013 field activities with respect to IDW, that leave conditions essentially unchanged, should not require a detailed analysis of ARARs or assurance that conditions at the site will comply with the ARARs. At the same time, field personnel conducting the 2013 field activities should ensure that their handling of IDW does not create additional hazards at the site.

In brief, compliance with the NCP can generally be assured by:

1) Identifying contaminants, if any, present in the IDW based upon existing information and best professional judgement; testing is not required in most circumstances.

2) Determining ARARs and the extent to which it is practicable to comply with them.

3) Delineating an AOC unit based upon existing information and visual observation if soil cuttings are RCRA hazardous.

4) Burying RCRA hazardous soil cuttings within the AOC unit, so long as no increased hazard to human health and the environment will be created. Containerization and testing are not required.

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5) Containerizing RCRA hazardous groundwater and other RCRA hazardous IDW such as PPE, disposable sampling equipment, and decontamination fluids for off-site disposal.

4.2 HAZARDOUS WASTE REGULATION

The RCRA hazardous waste regulations are clearly ARARs for hazardous IDW generated and managed during the 2013 field activities. However, with the application of EPA IDW guidance, RCRA requirements apply to management of IDW in the following manner:

- If RCRA hazardous IDW is stored or disposed off-site, then comply with all RCRA (and other ARAR) requirements.

- If RCRA hazardous IDW is stored on-site, then comply with RCRA (and other ARAR) requirements to the extent practicable.

For the 2013 field activities, the following general guidance is expected to be practicable and therefore followed, recognizing that each situation will be evaluated against EPA IDW guidance (EPA, 1991) as well as RCRA hazardous waste requirements and other ARARs:

- IDW may be assumed not to be a "listed" hazardous waste under RCRA 40 CFR 261 Subpart D, unless available information about the site suggests otherwise.

- IDW characterization to determine if the IDW exhibits RCRA hazardous waste characteristics do not typically require testing if the characterization can be made by "applying knowledge of the hazardous characteristics in light of the materials or processes used" or by historical testing consistent with 40 CFR § 262.11(c).

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- Compliance with the RCRA hazardous waste generator requirements of 40 CFR Part 262 for all RCRA hazardous IDW generated and/or managed (with exception of soil cuttings managed in accordance with the EPA IDW guidance). It is presumed that the RCRA hazardous IDW generated will fall within the large quantity generator (LQG) requirements.

- Land disposal does <u>not</u> occur (and thus the Land Disposal Restrictions [LDR] of 40 CFR Part 268 are <u>not</u> applicable) when IDW soil cutting wastes are:

  - Moved, stored or left in place within a single AOC unit;
  - Capped in place;
  - Treated in situ (without moving the IDW to another AOC unit for treatment); or
  - Processed within the AOC unit to improve structural stability (without placing the IDW into another AOC unit for processing).

- Conversely, land disposal <u>does</u> occur (and the LDR of 40 CFR Part 268 <u>are</u> applicable) when IDW soil cutting wastes are:

  - Moved from one AOC unit to another AOC unit for disposal;
  - Moved outside an AOC unit for treatment or storage and returned to the same AOC unit for disposal;
  - Excavated from an AOC unit and placed in a container, tank, surface impoundment, etc. and then re-deposited back into the same AOC.

5.0 DESCRIPTION OF ANTICIPATED IDW MANAGEMENT

The following subsections provide a description of the anticipated IDW to be encountered, generated, and/or managed at the FMC Plant Operable Unit during the 2013 field activities and the anticipated management of each. It should be noted that this information is provided for planning purposes, and will be evaluated and may need to be revised based upon actual experience and waste determinations while on site.

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5.1 SOIL AND SOIL CUTTINGS

During the 2013 field activities, numerous test pits, trenches, and borings will be performed within the Western Undeveloped Area (WUA) of the FMC Plant Operable Unit to gain access to appropriate depths for soil sampling and to provide a source of clean soil for the test gamma cap. The WUA was determined during the SRI to be un-impacted, therefore, soils from this area will be managed as clean soils. There will also be extraction wells and sampling wells installed at the northeast corner of the FMC Plant OU. In addition to native soils, fill materials including slag and phosphate ore are expected to be encountered. Past analyses of these fill materials have determined that these fill materials do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all soil and soil cuttings managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Leaving on-site RCRA nonhazardous soil cuttings within the AOC where they are generated. Typically, this will involve placing soil cuttings back into the same investigation pit, trench, or bore hole (except finished wells) and in the same order from which the material was removed, to the extent practicable. For example, and effort will be made to segregate fill materials from native soils as soil cuttings are removed from a pit, trench, or bore hole. For finished wells, the soil cuttings will be spread out at the surface near the bore hole. The placement of the soil cuttings back into the pit, trench or bore hole will typically involve placement of the native soils back first, followed by the fill materials. This should ensure that there are not additional hazards created at the site and that site conditions remain essentially unchanged.

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5.2 WELL DEVELOPMENT AND PURGE FLUIDS

During the 2013 field activities, groundwater extraction wells and piezometers are anticipated to be installed in the northeast area of the FMC Plant Site. Fluids will be generated during the development the wells and piezometers and purge water will be generated during the planned pump testing of the extraction wells. Over 20 years of analyses of groundwater from monitoring wells in the proximity of the planned wells / piezometers do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all well development and purge fluids managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Containment of well development / purge fluids as generated to await waste determination.

- Characterizing the well development / purge fluids through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The well development / purge liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- Any well development / purge liquids that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

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5.3 SPENT SAMPLING-RELATED EQUIPMENT

During the 2013 field activities, spent sampling-related equipment may be generated. This may include (but not limited to) plastic sheeting/tarps, rope, bailers, sampling equipment, spent PPE, sample bottles, used containers, packaging materials, and other consumables. The spent sampling-related equipment is expected to be nonhazardous, based upon historical and SRI data collected.

While the spent sampling-related equipment will be evaluated on a case-by-case basis, the general approach to be followed for spent sampling-related equipment IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containerizing the spent sampling-related equipment at the point of generation.
- Characterizing the spent sampling-related equipment IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.
- Those spent sampling-related equipment IDW that are determined to be nonhazardous will be disposed along with other Site non-hazardous solid waste.
- Those spent sampling-related equipment IDW that are determined to be hazardous (although not expected) will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

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5.4 DECONTAMINATION FLUIDS AND SOLIDS

5.4.1 Decontamination Fluids and Solids Associated with Drilling, Digging, and/or Trenching

During the 2013 field activities, decontamination fluids and solids will be generated. Typically, these will be generated at a common decon area, although there may be more than one decon area. Typically, the decontamination IDW will include (but not limited to) washwater from equipment, cleaning agents, cleaning utensils, and spent PPE (along with associated contaminants). Although this decontamination IDW is expected to be nonhazardous, waste determinations will be performed on each waste stream.

5.4.2 Decontamination Fluids and Solids Associated with Sewer Pipe Investigation

Decontamination fluids and solids are expected to be generated during the video inspection of the storm sewers in RA-A. This is the only 2013 field activity in which field equipment is expected to come into contact with site materials contaminated with elemental phosphorus (P4). While the decontamination wash and rinse waters are expected to be non-hazardous, they may contain small amounts of P4.

5.4.3 Decontamination Fluids and Solids Waste Management

While the decontamination IDW will be evaluated on a case-by-case basis, the general approach to be followed for decontamination IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containment of decontamination fluids (typically washwater) as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad). Washwater will then be containerized to await waste

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determination. Solids will also be containerized in a separate container to await waste determination.

- Other decontamination solids such as cleaning utensils and PPE will also be containerized to await waste determination.

- Characterizing the decontamination IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The decontamination solids IDW that are determined to be nonhazardous will be disposed in on-site.

- The decontamination liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- The decontamination IDW (either liquid or solid) that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

6.0 PROCEDURES FOR HAZARDOUS IDW MANAGEMENT

Although hazardous IDW is not expected to be generated, the following procedures apply to all IDW that have been determined to be hazardous except for soil cuttings IDW that remain with the AOC unit.

6.1 INTRODUCTION

Once an IDW has been determined to be hazardous, the federal RCRA Subtitle C waste management requirements apply to that waste. The scope of this procedure covers the

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requirements for large quantity generators of hazardous IDW which manage the hazardous IDW on site such that RCRA permitting is not required.

6.2 DETERMINE LAND DISPOSAL RESTRICTIONS

The 1984 amendments to the RCRA law included a prohibition of land disposal of certain hazardous wastes without first meeting some treatment standards. For the most part, all listed and characteristic hazardous wastes must be treated according to the treatment levels and technologies outlined in 40 CFR Part 268 to reduce the toxicity and/or mobility of hazardous constituents prior to being disposed of on the land, i.e., landfilled. Therefore, a generator must determine if the waste is a "restricted waste" under the land ban rules, and if so, off site treatment and disposal is limited. Note that these rules apply only to wastes destined for land disposal which is defined as: placement in or on the land including a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, underground mine or cave, or concrete vault or bunker. Wastes which are shipped off site for disposal other than land disposal are not regulated under the land disposal restriction regulations of 40 CFR Part 268.

Generators of hazardous wastes must determine if the waste is restricted from land disposal under 40 CFR Part 268. The following reporting and recordkeeping requirements apply.

- If a generator determines that he is managing a restricted waste and the waste does not meet the applicable treatment standards, with each shipment of waste, the generator must notify the treatment or storage facility in writing of the appropriate treatment standards;
- If the generator determines that he is managing a restricted waste and the waste can be disposed without further treatment, with each shipment of waste, the generator must submit to the treatment, storage or disposal facility a notice and certification stating that the waste meets the applicable treatment standards;

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- If the generator determines that he is managing a waste subject to an exemption from a prohibition on the type of land disposal method utilized for the waste, with each shipment of waste, the generator must submit to the receiving facility a notice stating that the waste is not prohibited from land disposal;
- If the generator is managing prohibited waste in tanks, containers, or containment buildings regulated under 40 CFR 262.34, and is treating such waste in such tanks, containers, or containment buildings to meet applicable treatment standards, the generator must develop a waste analysis plan which describes the procedures the generator will carry out to comply with the treatment standards; and
- If the generator determines whether the waste is restricted based solely on his knowledge of the waste, all supporting data used to make this determination must be retained on-site in the generator's files.

The generator must retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to these requirements for at least three years from the date the waste was last shipped from the site. It should also be noted that it is prohibited to dilute a hazardous waste in order to circumvent the land disposal prohibitions (40 CFR 268.3). Once a waste is determined to be a "restricted waste", an appropriate Treatment, Storage, and Disposal Facility (TSDF) can be selected to properly treat and dispose of the waste.

6.3 ON-SITE ACCUMULATION

As discussed in Section 5.0 above for each IDW generated, a large quantity generator (LQG) must make the appropriate hazardous waste determination per 40 CFR Part 262.11. If the IDW is determined to be hazardous, then the IDW will typically be stored on-site prior to shipment off-site for disposal. The following requirements apply to all hazardous IDW being stored on-site prior to shipment.

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6.3.1 EPA Identification Number (40 CFR Part 262.12)

Any facility which is a LQG of hazardous wastes must not treat, store, dispose, transport or offer for transportation any hazardous waste without first obtaining a EPA identification number from EPA (or the authorized state). Hazardous wastes cannot be offered to transporters or to treatment, storage or disposal facilities that have not received a EPA identification number. The FMC Plant Operable Unit has an EPA ID number of IDD070929518 which will be used on all manifests for shipments of hazardous IDW for off-site disposal.

6.3.2 On-Site Hazardous Waste Accumulation (Storage) (40 CFR 262.34(d))

Two types of accumulation areas for hazardous waste are permissible for a LQG without RCRA interim status or a Part B permit. These are the "90-day storage area" and the "satellite accumulation station" (SAS). The SAS requirements are discussed below. With regards to a "90-day storage area", a LQG may store hazardous wastes on-site for up to 90 days or less in a storage area, provided that the following conditions are met:

- If the waste is placed in containers, the requirements of 40 CFR Part 265 Subpart I (container requirements) are met. See below for container requirements;
- If the waste is placed in tanks, the requirements of 40 CFR 265 Subpart J (tank requirements) are met. See below for the tank requirements.
- At closure, the generator closes the storage area per the requirements of 40 CFR 265.111 and 40 CFR 265.114;
- The date which the hazardous waste is placed in the storage area is clearly marked on the container, and the container is clearly marked as "Hazardous Waste";
- The facility complies with 40 CFR Part 265 Subpart C, Preparedness and Prevention (See Section 6.3.3 below);

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- The facility complies with 40 CFR Part 265 Subpart D, Contingency Plan and Emergency Procedures (See Section 6.3.4);
- The facility complies with 40 CFR Part 265.16 training requirements (See Section 6.6 below);
- Any hazardous wastes which are stored longer than 90 days must first be granted an extension by EPA (or authorized state).

90-Day Storage Area Container Requirements (40 CFR Part 265 Subpart I)

Hazardous waste stored in containers must meet the following requirements:

- Containers must be in good condition, free of leaks;
- Hazardous wastes must be compatible with container (or liner) material;
- Containers must always be kept closed except to add or remove wastes;
- Containers must be handled in a manner to avoid ruptures;
- The storage area must be inspected at least weekly to check for container deterioration; and
- Incompatible wastes must be stored separately with separate secondary containment.

Incompatible wastes are wastes that are unsuitable for co-mingling because the co-mingling could result in any of the following:

- Extreme heat or pressure generation;
- Fire;
- Explosion or violent reaction;
- Formation of substances that have the potential to react violently;
- Formation of toxic dusts, mists, fumes, gases, or other chemicals; and/or
- Volatization of ignitable or toxic chemicals due to heat generation.

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90-Day Storage Area Tank Requirements (40 CFR Subpart J)

LQGs that accumulate or store hazardous wastes in tanks or tank systems must meet the following requirements:

- For tanks existing prior to July 14, 1986, an assessment of tank must be performed and certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.191);
- New tank systems (those built after July 14, 1986) must meet tank technical standards and have been certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.192);
- New tank systems must have adequate secondary containment and leak detection systems. Existing tanks must be upgraded to meet these standards by the time the tank is 15 years of age (40 CFR 265.193);
- Tanks must be operated to prevent system failure, overflow and spills. Tanks must be operated with sufficient freeboard to prevent overtopping (40 CFR 265.194);
- Inspect the tanks at least once each operating day for the following:
  - Discharge control equipment;
  - Monitoring equipment and controls;
  - Tank level; and
  - Evidence of leaks or spills. (40 CFR 265.195)
- Inspect the tanks at least weekly for corrosion, erosion or leaks;
  - The tank must meet the closure and post-closure care provisions of 40 CFR 265.197; and
  - Store incompatible wastes separately (40 CFR 265.199).

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Satellite Accumulation Station (SAS) Requirements (40 CFR 262.34(c))

A SAS is a container placed at or near the point of waste generation for the purpose of collecting the waste as it is being generated. For example, a container may be placed in the quality control laboratory for collection of hazardous wastes generated in the laboratory. This SAS may collect up to 55 gallons of hazardous waste or 1 quart of acute hazardous waste. The SAS does not need to meet the requirements of a storage area, provided the following conditions are met:

- The amount of hazardous waste accumulated at the SAS does not exceed 55 gallons (or 1 quart of acute hazardous waste);
- The SAS is located at or near the point of generation where the waste is initially accumulated and is under the control of the operator of the process generating the waste;
- The container used is in good condition, is compatible with the wastes being accumulated, and is kept closed except to add or remove wastes;
- The container is marked with the words "Hazardous Waste" or other words to identify the contents; and
- Once the 55-gallon limit is reached, the date is marked on the container and the container is moved from the SAS within three days to a proper location. For example, the wastes must either be moved to the storage area or be picked up by a waste transporter and moved off-site.

6.3.3 Preparedness and Prevention (40 CFR Part 265 Subpart C)

The following preparedness and prevention steps must be taken concerning the hazardous waste storage area:

- The storage area must be operated and maintained to minimize the possibility of fire, explosions or releases of hazardous waste;

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- The facility must have appropriate communication systems, fire-fighting equipment, spill control equipment and decontamination equipment;
- All emergency response systems and equipment must be tested monthly with documentation and maintained to assure proper operation;
- Persons handling hazardous wastes must have immediate access to alarms and/or communication systems;
- The storage area shall have adequate aisle space for emergency response activities; and
- The facility must attempt to make arrangements with the local police, fire departments, emergency response teams, and local hospitals to assure readiness for potential emergencies associated with the storage area.

6.3.4 Contingency Plan and Emergency Procedures (40 CFR Subpart D)

A LQG that accumulates or stores hazardous waste on site in a 90-day storage area must develop and keep current a contingency plan for the facility. The purpose of the contingency plan is to provide an organized plan of action and delegation of responsibilities and authority to specific facility personnel to respond to emergency situations that may require both the facility and/or outside resources. The contingency plan is designed to minimize hazards to humans or the environment from fires, explosion or any unplanned sudden or non-sudden release of hazardous waste/hazardous waste constituent to air, soil or surface water in compliance with the requirements of 40 CFR 265 Subpart D. MWH will maintain a Contingency Plan on the site if hazardous IDW are accumulated on-site.

The key components of the contingency plan include the following (40 CFR 265.52):

- A description of the emergency response organization, including designation of the Emergency Coordinator and alternates;
- Response procedures;

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- Emergency notification;
- Arrangements with local authorities;
- List of names, addresses and phone numbers of designated emergency personnel and alternates;
- List of emergency response communication equipment and locations;
- Evacuation procedures, routes and alternates; and
- Procedures for amending the plan.

Copies of the plan must be sent to (40 CFR 265.53):

- The FMC Project Manager;
- Power County Sheriff's department;
- Pocatello fire department; and
- Other agencies as deemed appropriate.

The emergency coordinator (EC) is the key person facilitating emergency preparedness and response. The EC or designated alternate shall be on-site or on-call at all times. The EC and alternates must be trained and thoroughly familiar with the contingency plan, emergency response activities and operation of the facility. The EC must know the locations and characteristics of all waste generated, location of all records within the facility and the facility layout. The EC must have the authority to commit the resources needed to carry out the spill response plan. Any person or department who first discovers any spill of a hazardous waste/material is responsible for notifying the spill response/emergency response coordinator. The EC for the 2013 field activities will be the EHS Officer with the Field Team Leader and the RDRA Project Manager as alternates.

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The contingency plan should be reviewed and immediately amended when:

- Changes in applicable regulations occur;
- The plan fails in an emergency;
- Changes are made to emergency procedures;
- Changes occur in emergency personnel list; or
- Changes occur in emergency equipment list.

6.4 PRE-TRANSPORTATION REQUIREMENTS

Prior to transporting hazardous wastes or offering hazardous wastes for transportation off-site, the generator must comply with the following:

- Package the hazardous wastes in DOT-approved containers per 49 CFR Parts 173, 178 and 179. DOT-approved containers (such as drums) are usually marked as being DOT-approved);
- Label the hazardous wastes according to DOT labeling requirements per 49 CFR Part 172;
- Mark each container (of 110 gallons or less) used in transportation with the following:

  HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the EPA.

  - Generator's Name and Address
  - Manifest Document Number
- Ensure that the initial transporter placards the transport vehicle with the appropriate placard in accordance with 49 CFR Part 172 Subpart F.

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6.5 MANIFESTING OFF-SITE SHIPMENTS OF HAZARDOUS IDW

Any generator which transports or offers for transportation hazardous waste for off-site treatment, storage or disposal must prepare a manifest according to manifest instructions for each shipment of similar hazardous wastes. The manifest must be carefully filled out with each shipment. Take care to follow the instructions and use the terms as listed in the instructions. A generator must designate on the manifest one facility (designated facility) which is permitted to handle the waste described on the manifest (40 CFR 262.20).

The generator must determine if the state to which the wastes are destined (consignment state) requires use of its own manifest. If so, then the consignment state's manifest must be used. If the consignment state does not require use of its manifest, and the state in which the waste shipment originates (generator state) does, then the manifest from the generator state must be used. If both states have manifests, use the consignment state manifest, making sure that there are sufficient copies to meet the generator state distribution requirements. If neither state requires use of its manifest, then any uniform hazardous waste manifest may be used (40 CFR 262.21).

The manifest must contain at least enough copies such that the generator gets two copies, the transporter gets one copy and the designated facility gets one copy. Some states require additional copies to be sent to the state. At the time of shipment, the generator must keep one copy (the generator copy) of the completed, signed manifest and give the remaining copies to the transporter. Each copy must have the signature of the generator and the transporter at the time of shipment. The original manifest shall be returned to the generator once the shipment reaches the designated facility and the manifest is signed by the designated facility (40 CFR 262.21).

If the original, signed manifest is not received by the generator within a certain number of days, action by the generator is required. These requirements are discussed in the following sections:

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- If, after 35 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must contact the transporter and/or the designated disposal facility to determine the status of the hazardous waste (40 CFR 262.42(a)(1)).
- If after 45 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must submit an exception report to the U.S. EPA (or authorized state). The exception report must include a copy of the manifest along with an explanation of efforts to locate the hazardous wastes and the result of these efforts (40 CFR 262.42(a)(2)).

6.6 PERSONNEL TRAINING

Any person, and their immediate supervisor(s), involved in waste management at a LQG facility which stores hazardous waste in a 90-day storage area must undergo initial and annual training for hazardous waste management (40 CFR 262.34(a)(4) and 40 CFR 265.16). Facility personnel are required to successfully complete a program of classroom instruction or on-the-job training that teaches them to perform hazardous waste management duties relevant to their jobs. The program must be directed by a person trained in hazardous waste management procedures.

The training must be designed to enable personnel to effectively respond to emergencies by becoming familiar with emergency procedures, emergency equipment and emergency systems, including the following;

- Procedures for using, inspecting, repairing and replacing facility emergency and monitoring equipment;
- Communications or alarm systems;
- Response to fires or explosions; and
- Off-site communication.

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Employee training is to be held at regular intervals. Emergency planning information, e.g., the Contingency Plan, also should be provided to state and local emergency response agencies at regular intervals (40 CFR 265.37 and 265.53). Employees required to receive the training cannot work unsupervised until they have completed the training requirements (either classroom or on-the-job training). In addition, facility personnel must take part in an annual review of the initial training.

The following records must be maintained at the facility for employees affected by this training:

- Job title for each position and name of employee filling each job;
- Job descriptions for each position related to hazardous waste management;
- Written description of type and amount of initial and continuing training that will be given to each person filling the various job positions; and
- Documentation that necessary training has been given and completed by each affected personnel.

Training records are required to be kept on current personnel until closure of the facility. For former employees, training records must be kept for at least three years from the date the employee last worked at the facility and may be transferred if the employee stays within the same company (40 CFR 265.16(e).

6.7 REPORTING AND RECORDKEEPING

The following reports are required of a LQG:

- Manifest exception reports as discussed in Section 6.5 above.
- A LQG must submit a Biennial Report to the EPA (or authorized state) every even numbered year by March 1, e.g., March 1, 2008 for the 2007 reporting year. The Biennial Report is to be submitted on EPA form 8700-13A.

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The following records are required to be kept for a minimum of three years by the LQG:

- The signed original manifests;
- Biennial reports;
- Exception reports;
- All records pertaining to hazardous waste determinations; and
- Land disposal determination records, notification and certification records.

7.0 REFERENCES

EPA, 1991. Management of Investigation-Derived Wastes During Site Inspections, EPA May 1991, EPA/540/G-91/009

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STANDARD OPERATING PROCEDURE 7
HIGH PRESSURE IONIZATION CHAMBER SETUP AND OPERATION

1. PURPOSE

The purpose of the procedure is to instruct the user on how to properly setup and operate a High Pressure Ion Chamber (HPIC) to make gamma radiation exposure measurements

2. DISCUSSION

This procedure applies to the GE-Energy (formerly Reuter-Stokes) HPIC Model RSS-131, or equivalent.

3. PROCEDURE

3.1 Equipment

3.1.1 High Pressure Ion Chamber and tripod.

3.1.2 Cable.

3.1.3 Computer.

3.2 Setup

3.2.1 Load the RSS-131 software to laptop or desktop using the provided CD

3.2.2 Connect HPIC to laptop using RS232 cable.

3.2.2.1 Connect round 8-pin connector to COM Port 4 on HPIC

3.2.2.2 Connect DB-9 serial connector to COM 1 on computer.

3.2.3 Open RSS-131 Configuration Utility on computer.

3.2.3.1 From the configuration Utility you can change the HPIC settings such as logging time, format, etc. Refer to the RSS-131 manual for more details.

3.3 Operation

3.3.1 The HPIC logs reading whether or not it is connected to a computer. You can turn the detector on/off as needed between locations.

3.3.2 When the HPIC is initially turned on, the exposure rate readings will spike. After approximately 2-3 minutes the readings will have stabilized.

3.3.3 After the stabilization period, the HPIC will continue to collect readings according to the logging settings. The collection period should be defined by project specific instructions.

3.3.4 At each location, the date, location, collection start and stop time should be noted in the field log book.

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3.4 Downloading data

3.4.1 Upon completion of data collection, the data can be downloaded to a computer. Connect the PC to the HPIC according to section 3.2 or the HPIC User's Manual.

3.4.2 Open the Utility program, from the Online menu select the 'Upload sensor data from RSS-131' option. The data can be downloaded in .csv format. The data can be viewed, managed and displayed in Microsoft Excel.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the HPIC and associated computer program utilities.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and/or electronic files and stored with field notebooks and/or equipment folders or files.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 No Attachments.

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

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STANDARD OPERATING PROCEDURE 8
FUNCTION CHECK OF EQUIPMENT

1. PURPOSE

To describe the procedures for operational check-out and function check of radiation detectors and meters prior to collecting data.

2. DISCUSSION

The site manager is responsible for assuring that this procedure is implemented. The survey team members are responsible for following the procedure. It is imperative that the equipment is properly function checked each day of use and documented.

3. PROCEDURE

3.1 Equipment

3.1.1 Ratemeters and/or Scalers including Ludlum Models 2221, 2241, 3, 12, 19, 2360, or equivalent

3.1.2 Detectors including Ludlum models 44-10, 44-9, 44-2, 44-116, 43-5, 43-89, 43-93, or equivalent

3.1.3 Cable: C-C or other connectors, as applicable

3.1.4 Record Forms: ERG Form 1.30A (single channel detector) or 1.30B (dual channel detector)

3.1.5 Radiological check sources, typically Th-230 (alpha), Tc-99 (beta), and/or Cs-137 (gamma) sources

3.1.6 Calibration Jig

3.1.7 Instrument Manuals

3.2 Initial Instrument Field Check Out.

3.2.1 The following instructions should be followed unless otherwise directed by Project Manager.

3.2.2 Create a Function Check Form for each piece of equipment being used. Record serial numbers, calibration dates, and check source information in the appropriate fields. Under comments, record source to detector distance, site name, and location on site where function check is performed.

3.2.3 Check the instrument to assure that the settings are consistent with the calibration data. This means the Battery, High Voltage, Threshold, and Window Settings must be set

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according to those used in the original calibration or set up. Check with the Project Manager if in doubt or if changes are necessary for site specific reasons.

3.2.4 Replace the batteries in the meter if they indicate that they are near the low voltage level. Record all settings including the battery voltage on the Function Check Form.

3.2.5 With the meter in the rate meter position and a meter scale selected so that the meter is not pegged (other than the log scale), move both ends of the detector cable to determine if the cable is functioning properly. A faulty cable will introduce spurious counts. To test a cable, move both ends of the cable watching the meter. If excessive counts occur the cable may be faulty. Replace with a new cable of identical size and repeat the test. Document faulty cable and dispose of cable.

3.2.6 Select a location to perform the function check. This location should be selected with the following conditions in mind:

3.2.6.1 The location should represent background conditions for the site.

3.2.6.2 The radiological conditions surrounding the location should be expected to remain consistent throughout the duration of the project.

3.2.6.3 This will be the location that all function and source checks will be performed at the beginning of the work day and the end of the work day for the duration of the project.

3.2.7 With the detector placed in the fixed geometry position with no radioactive check source present, perform 1-minute scaler count and record the background count rate on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.8 Repeat the 1-minute scaler counts with the radioactive check source in place. Record the results on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.9 With Project Managers assistance determine the acceptable daily function check range. Typically this range will be the average of the initial ten counts plus or minus ten percent.

3.3 Daily Function Check.

3.3.1 The daily function check is typically performed twice daily, once before work activities have commenced and a second time when work activities have been completed. Follow steps 3.3.3 – 3.3.6 below for each time a function check is performed. If equipment is used for only a brief period of time, less than 1 hour, then a single daily pre-operations function check may be necessary.

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3.3.2 Create a Daily Function Check form for each piece of equipment being used as described in 3.2.2 above. In the comments field note that the form is being used as a daily function check form.

3.3.3 Follow steps 3.2.3 – 3.2.5 above.

3.3.4 Measure the background count for one minute (unless otherwise directed by project manager) at the previously identified function check location (see 3.2.6 above). Record on the Daily Function Check form.

3.3.5 Repeat 3.3.4 with the check source in place. If the detector is dual channel (alpha/beta) then repeat again with the second source in place.

3.3.6 If the daily function check results do not fall within the acceptable daily function check range, as discussed in Section 3.2.9 above, check the source, geometry and immediate area to determine if anything may have caused the check to fail. If a reason is found attempt to fix the problem. Count again. If the daily function check results in a second failure remove the instrument from service and report the event to the Project Manager.

4. TRAINING

4.1 Prior to performance of calibrations or use in the field, all personnel must show proficiency in the operation of the detectors and meters being utilized.

4.2 Prior to use in the field, all personnel must show proficiency in use of the function check forms.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG’s record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as hard copies and stored with instrument folders and/or project files.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

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7. ATTACHMENTS

7.1 Form 1.30A – Function Check Form (Single Channel)

7.2 Form 1.30B – Function Check Form (Dual Channel)

Author's Signature:	**Reviewed By:**
Charles P. Farr	Kenneth R Baker

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FMC

FMC Idaho LLC, Pocatello, Idaho

FMC OU Remedial Design
DATA GAP WORK PLAN

July 2013

MWH

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ACRONYMS/ABBREVIATIONS

ASTM	Association of Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DQCR	Daily Quality Control Reports
DQO	data quality objective
ET	Evapotranspirative or evapotranspiration
EMF	Eastern Michaud Flat
FTL	Field Team Leader
ft	feet
HSM	Health and Safety Manager
in	inch
IROD	Interim Record of Decision
MDD	maximum dry density
OMC	optimal moisture content
OU	operable unit
pcf	pounds per cubic foot
QAPP	Quality assurance Project Plan
RA	remedial area
RAO	remedial action objective
RDRA	Remedial Design/Remedial Action
SFS	Supplemental Feasibility Study
SOP	Standard Operating Procedures
SRI	Supplemental Remedial Investigation
UAO	Unilateral Administrative Order
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
WUA	Western Undeveloped Area

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1.0 INTRODUCTION

As specified in the *Interim Amendment to the Record of Decision for the EMF Superfund Site FMC Operable Unit* (IROD; EPA 2012), the selected soil remedy for the FMC OU includes the construction of soil covers over specified remediation areas (RAs). Two soil cover designs are specified: gamma cap and evapotranspiration (ET) cap. The preliminary designs for these soil covers are summarized below:

- The ET soil cover design consists of a minimum cover thickness of 24 inches of soil that will provide sufficient water storage and an additional 6 inches of soil to address potential long-term erosion of the cover. The design basis is presented in the *Comparison of Conventional and Alternative Capping Systems for Use at the FMC Plant OU (Capping Memorandum*) contained in Appendix D of the *Supplemental Feasibility Study Report for the FMC Plant Operable Unit* (*SFS Report,* MWH, 2010a).

- The gamma soil cover consists of a nominal 12 inches soil and is expected to provide sufficient gamma shielding from underlying fill materials. As described in the Remedial Design Work Plan (RDWP; MWH, 2013a), a gamma cap performance evaluation will be detailed in the separately-submitted Gamma Cap Performance Evaluation Work Plan.

The selected remedy requires approximately 155 acres of ET soil covers and 340 acres of gamma soil covers. The soil to be used for construction of both types of covers will be removed from the Western Undeveloped Area (WUA), an area of the westernmost portion of the FMC Plant OU that was never used in the phosphorus manufacturing process. Additional site-specific soil data from the WUA is required to proceed with cover design. This work plan details the additional soil sampling and material (geotechnical) testing required to better define the volume of available borrow soil and its material properties to finalize the design of the soil covers.

As specified in the IROD, the selected groundwater remedy for the FMC OU includes groundwater extraction and treatment, with treatment either at the City of Pocatello POTW or by a water treatment facility built within the FMC OU. The latter alternative would discharge treated water to an infiltration basin, from which it would either percolate down to groundwater or evaporate to the atmosphere. FMC is evaluating both of these treatment options. This work plan accordingly also includes collection of soil percolation data to support the evaluation and potential design of the onsite percolation/ evaporation basin(s).

Another remedial action requirement of the IROD is that elemental phosphorus residues that may remain in underground 16-inch, reinforced concrete storm/sewer piping in RA-A must be removed and disposed of offsite. This work plan includes procedures for performing a video survey of that underground storm drain piping to better understand the volume of residual solids it contains and support design of this element of the remedial action.

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1.1 REGULATORY BACKGROUND

On June 10, 2013, EPA Region 10 issued a Unilateral Administrative Order to FMC for Remedial Design and Remedial Action (UAO for RD/RA, or UAO; EPA 2013), EPA Docket No. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-10-2013-0116. The UAO for RD/RA requires FMC to implement the interim remedial actions that EPA selected in its September 27, 2012 Interim Record of Decision Amendment for the FMC OU ("IROD"). FMC is implementing the selected remedy in accordance with the UAO.

As summarized in Section 3 of the Remedial Design Work Plan for the FMC OU (RDWP; MWH, 2013a), this Data Gap Work Plan has been prepared and submitted to support the RD as defined in of Section IX, Paragraph 30 a. and 30 b. of the UAO and has been prepared in accordance with *Superfund Remedial Design and Remedial Action Guidance* (EPA, 1986).

1.2 FMC SITE DESCRIPTION

A description of the FMC OU is presented in Section 2 of the RDWP. A site map showing the FMC OU RAs and WUA is provided on Figure 1-1.

1.3 PURPOSE AND SCOPE OF WORK PLAN

This work plan has been developed to provide the following:

1. Confirm soil properties (geotechnical, hydrological, agronomical, vegetative) to support design of the ET soil covers; and evaluate potential design of the infiltration basin option for managing treated groundwater; ;
2. Develop a borrow source availability evaluation (material balance) for soils planned for use in constructing the ET and gamma soil covers;
3. Develop soil percolation rates to support potential design of the onsite percolation/evaporation system alternative for managing treated groundwater;
4. Present a sampling and analysis plan for collecting the supplemental data necessary to scope the stormwater piping remedial action for residual solids; and
5. Present a Quality Assurance Project Plan (QAPP) for the field work and geotechnical laboratory testing required to obtain data under this plan.

1.4 DOCUMENT ORGANIZATION

The remainder of this Work Plan consists of the following:

- Section 2.0 Data Gap Evaluation – Provides a summary of the data and design assumptions used for the developing the conceptual design of the ET soil cover presented in the Capping Memorandum, and identifies data gaps requiring additional investigations to support the RDRA.
- Section 3.0 Data Gap Sampling and Analysis Plan – Presents the work plan for completing the necessary investigations to fulfill the data gaps identified in Section 2.0.

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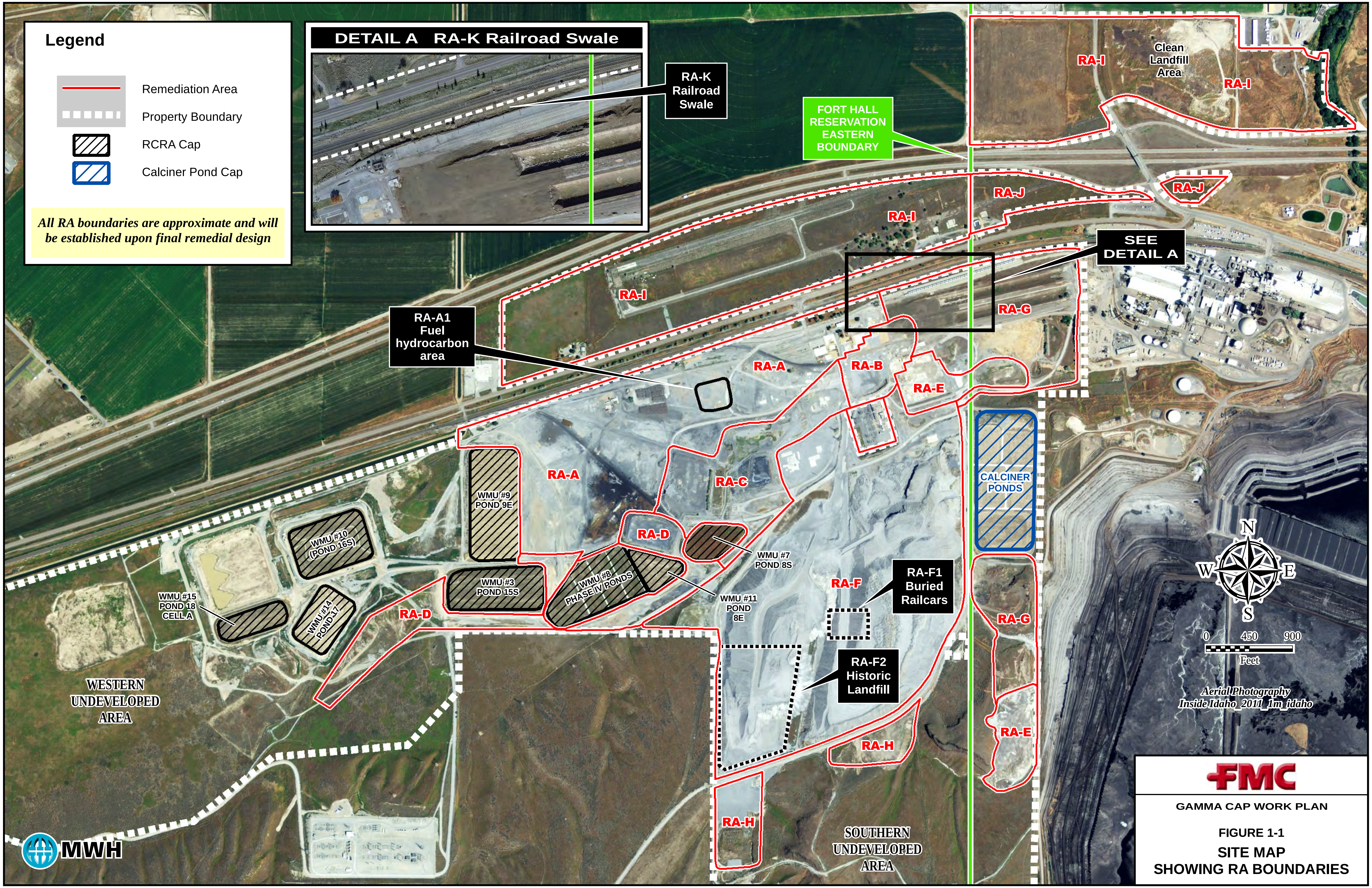
- Section 4.0 Quality Assurance Project Plan (QAPP) – Presents the requirements for meeting the quality performance objectives of the data gap investigation.
- Section 5.0 references the Health and Safety Plan.
- Section 6.0 presents the project schedule and deliverables.
- Section 7.0 contains references.
- Appendix A – Standard Operating Procedures
- Appendix B – Field Forms



FILE: I:\projects\FMCIdaho\FMC_DataGapWP\FIGURES\Fig 1-1_FMC_Site Map showing RA Boundaries_May2013.mxd

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2.0 DATA GAP EVALUATION

This section provides an evaluation of the current data available to support the design of the various soil covers presented in the SFS (MWH, 2010a) as well as identify data still required to design the ET and gamma soil covers.

2.1 PREVIOUS INVESTIGATIONS

The soil to be used for the ET and gamma soil covers will be obtained from the WUA located within the FMC OU. The preliminary design of the soil covers provided in the Capping Memorandum (MWH, 2009b) was based on testing data from soil samples collected from the WUA as part of the RCRA Pond closures (BEI,1998). During this investigation, a total of six soil samples were collected from the proposed borrow area and subjected to the following geotechnical and hydrogeological testing:

- Standard Proctor Compaction Test (ASTM D698);
- Particle Size Distribution (ASTM D422);
- Capillary-Moisture Relationship (ASTM D3152); and
- Saturated Hydraulic Conductivity (ASTM D5084).

Capillary-moisture relationship testing was performed to determine the soil moisture storage capacity of the borrow material. Based on the test results, the difference in moisture content of the soil between saturation (approximated to be field capacity) and -15,000 cm of pressure (approximated to the wilting point) was determined. These provided an approximation of the total amount of water that can be stored in the cover. For the purpose of the Capping Memorandum, the results for the samples remolded to 85% of modified Proctor were used, due to difficulties with achieving lower densities in the field. The results of the test yielded an average water storage capacity of 28.5 percent.

2.2 DATA REQUIREMENTS

This section describes the data gaps that have been identified for designing and constructing the ET and gamma soil covers and the removal of potentially P4-containing solids from the underground process piping in unit RA-A. The data gaps pertain to the following components of the site soils RD:

- Collect additional data pertaining to the geotechnical, hydrogeological and agronomic properties of the borrow soils located within the WUA to confirm soil properties related to the design of the ET and gamma soil covers;
- Verify likely vegetation properties as they pertain to root depth and density for use in infiltration modeling of the ET cover.

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- Quantify the amount of borrow material available within the WUA and if necessary other potential borrow areas for use in the construction of the soil covers;
- Determine the percolation rates of the gravels underlying the WUA for use in evaluating the efficacy of using that area as an infiltration gallery (for the groundwater remedy water management option B) following removal of the borrow soil for use in the soil covers.
- Conduct a video survey of the underground stormwater piping in RA-A to quantitatively determine the presence of accumulated solids potentially containing P4.

A detailed description of each required set of data is presented below. A sampling and analysis plan identifying the number of samples and frequency of test is presented in Section 3.

2.2.1 Confirmation of Soil Properties

ET soil covers reduce infiltration from precipitation by providing adequate water-storage capacity in the soil to contain the infiltrating precipitation and reduce or eliminate the flux of water migrating through the underlying waste. The water-storage capacity is optimized by identifying and selecting the most desirable soil properties during the design and development of construction specifications. In addition to optimizing the water-storage capacity, soil properties can be used to evaluate the long-term durability of the soil cover as it pertains to the shrink-swell and erosive potential of the soil.

Geotechnical Properties

As discussed in Section 2.1, some geotechnical properties have already been obtained from a limited number of soil samples collected from the WUA. However, given the amount of borrow soil required for the soil covers, additional data pertaining to the geotechnical properties of the soil is warranted to refine design values for incorporation into the project specifications. Therefore, the following testing will be performed to further define the geotechnical properties of the soil:

- Atterberg Limits testing will be collected to evaluate the shrink-swell potential of the soil and its propensity to develop desiccation cracks during cyclical wetting and drying.
- Standard Proctor testing will be collected to further refine the MDD and OMC of the soil to be used for specifying the percent compaction and in-place density of the soil.
- Particle size distribution testing will be conducted as an indicator of material properties across the entire borrow area. Generally, soils having the same or similar particle size distribution will have similar physical properties.
- Emerson Class testing will be used to evaluate the erosive potential of the soil due to dispersion.

Hydrological Properties

Typically, in a conventional landfill cover, the main property controlling water movement through the cover is saturated hydraulic conductivity, which approximates the ability of water to

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move through a soil under fully saturated conditions. However, due to the arid nature of the FMC OU, saturated conditions are unlikely to develop and as a result unsaturated flow conditions will control the movement of water through the soil cover. Previous hydrological studies of the soil from the WUA were confined to determining saturated hydraulic conductivity and capillary-moisture relationships. Although these parameters were used to approximate the water-storage capacity of the soil for the purpose of the conceptual ET cover design, additional testing to refine the unsaturated flow parameters is warranted. These parameters will be used to determine the soil water characteristic curve of the soil, which is necessary for performing numerical modeling of unsaturated flow through the cover system using Richard's equation. A numerical model will be used to confirm the thickness of the ET cover to be incorporated into the RD/RA. In addition to determining the water characteristic curve, the following water holding properties (as defined in SSSA, 1996) will be evaluated:

- Permanent wilting point – The largest water content of a soil at which indicator plants, growing in that soil, wilt and fail to recover when placed in a humid chamber;
- Field Capacity – The content of water on a mass or volume basis remaining in a soil 2 or 3 days after having been wetted with water and after free drainage is negligible;
- Available water – The amount of water released between in-situ field capacity and the permanent wilting point.

Agronomic Properties

Agronomic properties are those factors that affect plant growth and can be used to assess whether amendments are necessary to promote plant growth. Given that the main mechanism for removal of water from ET covers is through plant transpiration, the ability of the soil to sustain plant growth is of great importance. Therefore, the agronomic properties that could affect plant growth will be evaluated.

Vegetation Properties

Root depth and density are some of the most critical parameters when assessing potential transpiration rates associated with the ET cover. FMC previously performed a reclamation / vegetation viability study on a portion of the slag pile. For that study, FMC constructed several trial plots to assess that ability to establish vegetation on on-site derived soil used as cover material. To provide site-specific information associated with root depth and density, a survey will be performed on these former trial plots to provide an estimate of these parameters for use in performance modeling of the ET cover.

Percolation Study

The groundwater remedy requires groundwater extraction for hydraulic control. Under water management option 2, the extracted groundwater will be treated through an on-site water treatment system and would then be discharged via pipeline to the excavated portion of the

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WUA. The WUA consists primarily of silt soils underlain by gravels. It has been assumed that following removal of the silt soils for use in the soil covers, the WUA will be suitable as an infiltration gallery due to the presence of the underlying gravel strata. To evaluate this groundwater management option, the percolation rates of the gravels must be determined. Therefore, in conjunction with the borrow soil characterization, samples of the gravel will also be collected and permeability testing will be performed to evaluate the potential percolation rates required for the design of the infiltration gallery.

2.2.2 Borrow Soil Availability

Prior to finalization of the RD, a volume assessment of the soil available for use on the FMC OU is required. This assessment will focus first on the WUA as this is the most cost-effective borrow source location due to the shortest haulage distance. If the assessment concludes that the WUA has insufficient amounts of suitable borrow soil, other borrow sources will be identified and investigated as part of this assessment.

2.2.3 Underground Stormwater Piping Survey

A video survey of the underground stormwater piping underlying RA-A is necessary to determine the approximate volume of accumulated solids potentially containing P4. This information will be used to develop procedures for removal as well as estimating the volume of waste that will need to be managed as result of the removal.

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3.0 DATA GAP SAMPLING AND ANALYSIS PLAN

This section presents the Work Plan for addressing the data gaps identified in Section 2.0. Specifically, the sampling and analysis plan presents a detailed description of the following:

- Number samples to be collected;
- Type and frequency of testing to be performed;
- Methods for sampling;
- Procedures for performing the borrow source assessment; and
- Procedures for performing a survey of the underground process piping.

A QAPP for the field sampling and laboratory testing program is presented in Section 4.0. Standard operating procedures (SOP) for the geotechnical sampling are presented in Attachment A and the approximate sampling locations is presented in Figure 3-1. The SOPs provided were previously developed for the supplemental remedial investigation and will be used due to their applicability.

3.1 BORROW SOIL SAMPLING AND TESTING

3.1.1 Soil Sampling

Both disturbed and undisturbed samples will be collected from the WUA to characterize the in-situ and remodeled (from disturbed samples) properties of the soil. In-situ and remodeled properties are required to determine the difference in the moisture content and densities to better define the "bulking" factor that will be taken into account when calculating the bank amount of material required for constructing the soil covers. All samples will be collected in accordance with SOPs 05 and 06.

Disturbed samples will be collected from test pits excavated into the material using a trackhoe or similar excavation equipment. A total of 10 test pits will be excavated in a grid pattern throughout the WUA for the collection of disturbed samples. Test pits will be excavated to a depth accessible by the excavation equipment, which is expected to be around 10 feet below existing grade. A composite sample will be generated from soil samples collected from one foot depth intervals with each disturbed composite sample filling 2 5-gallon buckets. The samples will be collected from the excavator bucket outside of the excavation. Field sampling staff will not enter the excavation for sampling. A summary of the disturbed sampling procedures is presented in Table 3.1.

Undisturbed samples will be collected using a hammer rig fitted with a Shelby tube. A total of five bore holes, collocated with five of the test pits, will be collected and sampled at a depth between 2 and 3 feet and 6 and 8 feet below existing grade. The disturbed samples will be

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wrapped in plastic visqueen and placed in a cooler to preserve the moisture content of the soil. A summary of the undisturbed sampling procedures is presented in Table 3.1.

In addition to the undisturbed samples of borrow soil, additional disturbed samples of the underlying gravels will be collected using the same hammer rig and holes as used for the undisturbed samples. The gravel samples will be used for performing permeability test for evaluating percolation rates for use in designing the potential infiltration gallery. The gravels will be obtained by advancing the hammer caisson 10 feet into the gravels and "blowing" the material up through the caisson and collecting the material in one 5-gallon buckets. A summary of the gravel sampling procedures is presented in Table 3.1.

Table 3.1 – Summary of Soil Sampling Procedures

Sample Type	**Sampling Method**	**Sample Frequency**	**Sample Interval**	**Total Depth**	**Sample Quantity**
Disturbed Borrow Soil	Test Pit	10 Test Pits	1 composite sample per test pit made up of grab samples collected at 1 foot intervals	10 feet or until gravels are contacted	2 5-gallon buckets per test pit
Undisturbed Borrow Soil	Hammer Rig with Spilt Spoon	5 Bore-Holes	2 undisturbed samples collected from each bore hole at depths between 2 and 3 feet and 6 and 8 feet below ground surface	10 feet or until gravels are contacted	2 1 foot undisturbed samples per bore-hole
Gravels	Hammer Rig	5 Bore-Holes (same holes as undisturbed samples)	One disturbed sample per hole	10 feet into gravel horizon	One -5 gallon buckets per bore-hole

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3.1.2 Soil Testing

Both disturbed and undisturbed samples will be tested to determine the in-situ and remolded properties of the borrow soil. The testing program is provided in Table 3.2.

Table 3.2 – Soil Testing Program

Soil Test	Disturbed Samples	Undisturbed Samples	Gravel Samples
Standard Proctor Compaction Test (American Society of Test and Materials) ASTM D698)	One per sample	None	None
Particle Size Distribution (ASTM D422)	One per sample	None	One per sample
Atterberg Limits (ASTM D4318)	One per sample	None	None
Crumb Test	One per sample	None	None
Saturated Hydraulic Conductivity (ASTM D5084)	Two tests every other sample (total of 10 tests) 1 test @85% MDD 1 test @90% MDD	None	One per sample
Water Characteristic Curve Testing (ASTM D6836)	Two tests every other sample (total of 10 tests)	None	None
Agronomic Properties Phosphorus (EPA 6010B) Potassium (EPA 6010B) Sodium CEC (ASA 9) Specific Conductance (ASA 9) pH (EPA 9045C) Total Organic Matter (USDA HB60(24)) Total Organic Carbon (USDA HB60(24)) Plant Available Nitrogen (ASA 9)	One test total from composite sample of the 10 test pits	None	None
In situ Density (ASTM D7263-09) In-situ Moisture Content (ASTM D2216-10)	None	Two tests per bore hole (Total of 10 tests)	None

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3.2 VEGETATION SURVEY

A vegetation survey will be performed on the formerly-constructed vegetation trial plot area on the slag pile (refer to Figure 3-1 for location) to provide root depth and density. Data has already been collected from the currently capped Calciner Ponds related to plant density. To supplement this data and provide accurate inputs into the infiltration model, root density and depth surveys will be performed. The following methodology will be used for performing the vegetation survey:

1. Confirm top soil thickness is at least 18-inches by pushing a piece of rebar through the soil until the underlying slag is encountered;
2. Stake-out corners of survey area having greater than 18-inch soil thickness;
3. Divide survey area into 5 foot by 5 foot grids;
4. Collect 3 randomly located borings within each sampling grid using a hand auger;
5. Divide boring into discrete depth intervals of 0-6 in, 6-12 in, 12-18 in, and 18-24 in.
6. Record the weight and volume of each sample;
7. Wash soil from roots using a fine mesh strainer;
8. Place the roots in an oven for drying;
9. Weight the dried roots; and
10. Calculate biomass density by dividing dry mass of roots by volume of core.

3.3 UNDERGROUND STORMWATER PIPING SURVEY

The underground stormwater piping located in RA-A will be video surveyed to determine the approximately volume of accumulated solids with the potential presence of P4. FMC will utilize a qualified piping surveyor to perform the survey. It is estimated that a total of 1,350 feet of pipe will be surveyed. The video from the survey will be reviewed to approximate the volume of material that will require containerization and disposal. Decontamination of video surveillance equipment will be performed in accordance with SOP 02

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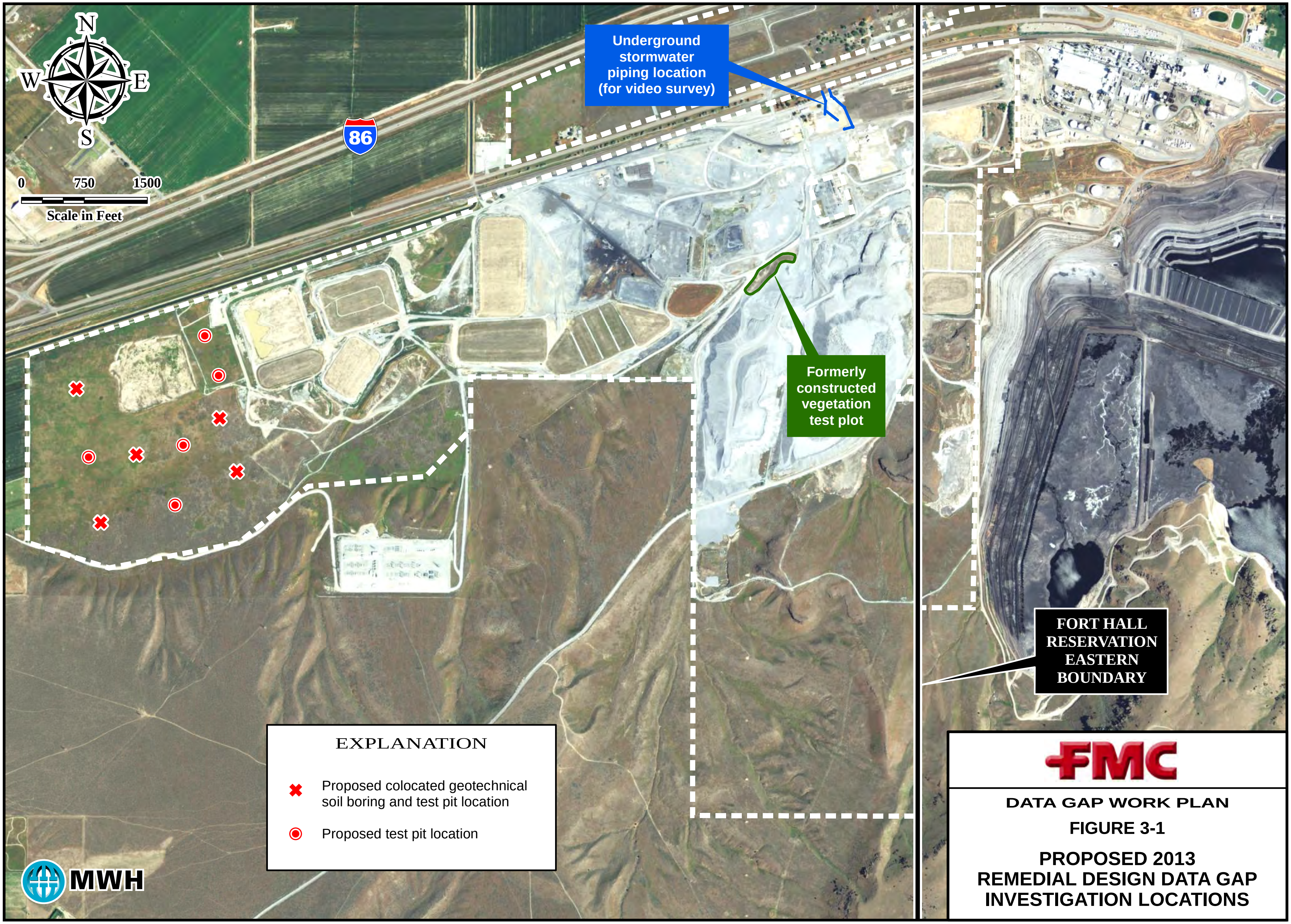

FMC

DATA GAP WORK PLAN

FIGURE 3-1

PROPOSED 2013 REMEDIAL DESIGN DATA GAP INVESTIGATION LOCATIONS

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4.0 QUALITY ASSURANCE PROJECT PLAN

4.1 INTRODUCTION

This section presents the QAPP as it pertains to soil sample collection, handling and testing of the soil samples for geotechnical, hydrological and agronomic properties. Applicable SOPs and Daily Quality Control Reports (DQCR) forms for the sampling activities are provided in Attachments A and B, respectively.

4.2 PROJECT TEAM AND ORGANIZATION

The overall organizational structure and key personnel for this Data Gap acquisition project and responsibility and authority of each team member is presented below.

4.2.1 EPA Remedial Project Manager

EPA is the lead agency governing the remediation of the FMC OU. EPA issued the IROD and UAO, and is responsible for approving all plans and reports related to implementing the selected remedy, including the Data Gap Work Plan. The EPA Remedial Project Manager is Mr. Kevin Rochlin.

4.2.2 FMC Project Coordinator

As the responsible party, FMC is implementing the selected remedy in accordance with the UAO. FMC has overall responsibility for procuring consultants and contractors to perform the work, budgeting and securing the necessary funds, and assuring that the requirements of the UAO are met. The FMC Project Coordinator is Ms. Barbara Ritchie.

4.2.3 **MWH** Project Director

Mr. Marc Bowman is the MWH Project Director. He will be responsible for the contractual commitments and for ensuring that the necessary resources are dedicated to the project and will assure the technical, budget, and schedule requirements are met.

4.2.4 MWH RD Manager

Mr. Rob Hartman is the MWH RD Manager and has overall responsibility for conducting the data gap acquisition project in accordance with this work plan. Mr. Hartman served as a technical lead on the FMC OU SRI/SFS and has extensive knowledge of the FMC OU.

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4.2.5 MWH Engineering Manager

Mr. Chad Tomlinson is the MWH Engineering Manager and will be responsible for coordinating the necessary resources to accomplish and the day-to-day technical elements of the data gap acquisition project. Mr. Tomlinson is a registered professional (civil) engineer (registered PE in Idaho) with a technical specialty in geotechnical engineering and served as the primary engineer during the FMC Plant OU SFS.

4.2.6 MWH Field Team Leader

Mr. Bill Bragdon will serve as field team leader (FTL) for the data gap investigation and will be responsible for coordinating the necessary field resources and for ensuring site health and safety. Mr. Bragdon has worked extensively on the FMC OU property during the supplemental remedial investigation.

4.2.7 Geotechnical Testing Laboratory

Intermountain Geoenvironmental Services, Inc. (IGES) will perform the geotechnical testing on samples collected during the data gap investigation. IGES is an ASTM-accredited laboratory capable of performing all required soil testing per ASTM standards.

4.3 DATA QUALITY OBJECTIVES

The data that will be collected during the execution of this work plan involves observation of field conditions (e.g., field soil classification, observation of in-pipe video display) and standard material property (geotechnical) and agronomic tests, and does not include any analytical (chemical) laboratory analyses. As described in Section 2.2, the data are being collected to fill specific data needs to finalize specific elements of the RD and there is no “problem statement” or “decisions” associated with the data. Thus, no specific, numeric data quality objectives (DQOs) have been established. However, the use of qualified field personnel (geologists/geotechnical engineers), use of standard (ASTM) material testing methods, and field documentation protocols described below will assure the data is suitable for the identified use (e.g., ET cap model, borrow soil volume calculation).

4.4 SAMPLING LABELING

All samples will be labeled in a clear, precise way for proper identification in the field and for tracking in the laboratory. The samples will have identifiable and unique numbers. At a minimum, the sample labels will contain the following information:

- facility name
- sample number

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- sample depth
- date of collection
- time of collection
- initials or name of person(s) collecting sampling
- analytical parameter(s)
- method of sample preservation

A coding system will be used to uniquely identify each sample collected. The system will allow for quick data retrieval and tracking to account for all samples. The sample designation will be recorded on the sample label and logbook, and will comprise three parts or fields.

- Samples will be numbered sequentially for each type of sample collected (i.e., test pit sampling and soil boring).
- Part 1 will be a field of up to five characters corresponding to the area and will be designated "WUA".
- Part 2 will be a field that begins with alphabetic characters that identify the type of sample. Sample-type codes include the following:
  - CO = collocated
  - S = solid (e.g., soil or gravel)
  - TP = test pit
  - SB = soil boring
- Three digits will follow the alphabetic character(s) and will be sequential (e.g., "001" for the first sample location collected, "002" for the second sample location collected, "003" for the third sample location collected). In the case of a soil boring, Part 2 will end with the depth interval, referenced to below ground surface (bgs) in parentheses.
- Part 3 is a 2-digit sequential container number.

As an example, sample designation WUA-SB004 (2-4'BGS)-02 is the second container of the 4th sample location in the WUA from a soil boring from two to four feet bgs.

The individual sample designations that make up a composite sample will be recorded and a new sample designation will be given to the composited sample. The composited sample designation will include the WUA number, the sample-type code, the alphabetic character "C", a sequential sample location number, a depth interval, and a 2-digit sample container number. For example,

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the first composite sample container collected at the first sample location for WUA from 0-to-2 feet below the native surface would be "WUA-SBC001(0-2'BNS)-01."

Depth interval and sample designations include:

- Depth interval designations:
  - 0-0' = surface
  - 0-2' = 0-2 foot interval
  - 2-10' = 2-10 foot interval
- Sample designations:
  - BGS = below ground surface
  - BNS = below native surface
  - SUR = surface

4.5 CHAIN-OF-CUSTODY

Each sample will be properly documented to facilitate timely, accurate, and complete analysis of the data. The documentation system is used to identify, track, and monitor each sample from the point of collection through final data reporting. Where practicable, this documentation system may be electronic. Chain-of-custody protocol will be implemented and followed for all samples. A sample is considered to be in a person's custody if it is: 1) in a person's physical possession, 2) in view of the person after taking possession, or 3) secured by that person so that no one can tamper with it.

Chain-of-custody forms will be used to ensure that the integrity of samples is maintained. Each form will include the following information:

- Sample number
- Date of collection
- Time of collection
- Sample depth
- Testing Requirements
- Method of sample preservation
- Number of sample containers
- Shipping arrangements and airbill number, as applicable

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- Recipient laboratories
- Signatures of parties relinquishing and receiving the sample at each transfer point

Whenever a change of custody takes place, both parties will sign and date the chain-of-custody form, with the relinquishing person retaining a copy of the form. The party that accepts custody will inspect the custody form and all accompanying documentation to ensure that the information is complete and accurate. Any discrepancies will be noted on the chain-of-custody form.

4.6 SAMPLE HANDLING AND SHIPPING

After collection, samples will be properly stored to prevent degradation of the integrity of the sample prior to its analysis. As applicable, this includes proper containerization storing the sample in a refrigerated environment, and analyzing the sample within prescribed holding times. Where practicable, FMC may electronically document sample handling, preservation, and storage.

Based on the undeveloped nature of the WUA and other potential borrow sources on the FMC property, elemental phosphorus (P4) or other hazardous constituents will not be present in samples collected for shipment. All samples designated for off-site laboratory analysis will be packaged and shipped in accordance with applicable U.S. Department of Transportation regulations. Samples will be sealed in the appropriate sampling container. Disturbed samples will be containerized in 55-gallon sealed buckets and undisturbed samples will be wrapped in visqueen plastic and placed in cylindrical containers. Custody seals will be placed on each sample container after collection such that it must be broken to open the container. Undisturbed samples will be packed securely in an ice chest or other appropriate container to preserve moisture in the soil. Sampling personnel will inventory the sample containers bottles from the Site prior to shipment to ensure that all samples listed on the chain-of-custody form are present.

The originals of the analysis request and chain-of-custody forms will be sealed in a waterproof plastic bag and placed inside the shipping container prior to sealing the container. The cooler will be taped shut using strapping tape over the hinges and custody seals placed across the top and sides of the cooler lid. Custody seals will be used to preserve the integrity of each sample container and cooler from the time the sample is collected until it is opened by the laboratory. Two or more custody seals will be signed, dated, and placed on the front and back of the sample cooler prior to transport. Clear tape will be placed over the custody seals to prevent inadvertent damage during shipping. The tape should not allow the seals to be lifted off with the tape and reaffixed without breaking the seal.

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4.7 PROJECT DOCUMENTATION

4.7.1 Field Logbooks

The on-site geologist/environmental scientist will use a weather-resistant, bound, survey-type field logbook with numbered, non-removable pages to record in black or blue indelible ink all field activities including soil sampling, trenching, drilling, etc. Daily information entered in the logbook will include:

- Dates and times
- Name and location of the work activities.
- Weather conditions
- Personnel, subcontractors and visitors on site
- Sample locations and methods (including sampling equipment), time of sample collection, and sample depths
- Samples submitted to the laboratory for analyses
- Sample type (e.g., soil)
- Name of carrier transporting the sample (e.g., name of laboratory and shipping carrier)
- Photograph numbers and descriptions (if applicable)
- Description of decontamination activities (if applicable)
- Schematic drawings of sample locations (if not done on field forms)
- Any deviations from this plan
- Health & Safety meetings including topics discussed and attendees
- Accidents including near misses
- Other relevant observations as the field work progresses
- Problems and corrective actions
- Field equipment calibration methods
- Investigation-Derived Waste

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At the end of each field day, the project field book will be dated and signed by the field person that took notes during the day. If the entire page is not used a line will be drawn through the unused portion of the page. If pages are accidentally skipped, a line will be drawn through the entire page. All corrections will be made by drawing a line through the erroneous information and initialing the change. “White-out” or its equivalent will not be used.

If electronic record-keeping systems are employed, procedures will ensure that:

- All original entries recorded are sufficiently backed up to avoid loss.
- A system that preserves both the original record and any changes to the record, inclusive of the identification of the individual making the change exists, and will be implemented.
- An archived record of all data entries will be protected to prevent unauthorized access or amendment of the electronic data.
- Entries will be complete enough to allow for the historical reconstruction of all records.
- The review of the records will be documented.

4.7.2 Daily Quality Control Report (DQCR) Form

DQCRs will be prepared by the FTL each day that fieldwork is performed. The completed DQCRs will summarize daily activities and will include:

- Dates and times
- The type of work performed
- The individuals performing the work
- Visitors and equipment on site
- Quality control activities
- Health and Safety
- Problems encountered and corrective actions taken
- Weather (including temperature, wind and humidity)
- The report number

The report number (on the bottom right) will start with number one on the initial report and then will be sequential through the duration of the project. The DQCR will be submitted to the Engineering Manager electronically at the end of each day and a hard copy will be kept in the project file. Examples of DQCR pages one and two are located in Attachment 2.

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4.7.3 Soil Boring Logs

After collecting the required samples for geotechnical analyses the field geologist will make a visual description of the soil type and other lithologic or physical characteristics. Lithologic or physical characteristics will include but not be limited to color, grain size, plasticity, density, soil moisture, odors, bedding, and other information needed to accurately describe the soil. Soil borings will be logged for fill material type and depth (if any), soil classification, and the interface between fill (if any) and native soil material. The soil will be classified as per Section 4.7.6. As well as providing a visual description of the soil, other information that may be entered on the Soil Boring Log Form will include:

- Boring ID number
- A sketch of the soil boring location
- Project name and job number
- Date drilled and date completed
- Logged by
- Total depth of the soil boring
- Diameter of soil boring
- Drilling contractor
- Drilling method
- Survey information including northing, easting and ground surface elevation
- Soil boring abandonment procedure
- Number of blows to drive sampler (if applicable)
- Soil sampler type
- Amount of soil recovered in sampler

The soil borings will be performed and samples collected in accordance with SOP-5, respectively. An example of the Soil Boring Log Form (title page and pages 2 and 3) is found in Appendix B.

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4.7.4 Trench – Test Pit Logs

Trenches and test pits will be excavated for soil sampling at selected locations as part of this plan and in accordance with SOP-6. A trench log will be completed for all trenches and test pits during this investigation. The field geologist will log the trench or test pit following the guidelines described for soil borings for soil classification. The field geologist will make a visual description of the soil type and other lithologic or physical characteristics such as color, grain size, plasticity, density, soil moisture, odors, bedding, interface between fill (if any) and native and other information needed to accurately describe the soil. The trench or test pit excavation will be logged at a safe distance away from the excavation. As well as providing a visual description of the soil, other information that may be entered on the trench-test pit log form will include:

- Trench or test pit ID number
- A sketch of the trench or test pit
- Project name and job number
- Date and time of excavation
- Logged by
- Trench profile including length, width, and depth
- Excavation contractor
- Quality control review
- Survey information including northing, easting, ground surface elevation of the corners of the excavation
- Trench abandonment procedure
- Number of soil samples collected, analysis and location of the samples

A detailed description of soil classification is presented in SOP-6. An example of the Trench and Test Pit Log Form is found in Appendix B.

4.7.5 Surveying

Surveyed locations will include soil borings and excavations (test-pits). It is anticipated that the surveying will be completed using a handheld GPS unit. A detailed description of the GPS and other surveying is found in SOP-3.

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All measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988. Each sampling location will be marked with a wooden stake, a wooden lath or pin flag and will have the corresponding sample identification number written on the marker. During surveying, the northing, easting and elevation will be stored in the GPS unit and downloaded onto a computer. In addition, the northing, easting and elevation will be recorded a bound field notebook.

The GPS unit will be checked daily for accuracy at a control point or benchmark with a known northing, easting and elevation. The northing, easting and elevation will be recorded on the daily GPS Benchmark Elevation Form located in Appendix A. Other information reported on the GPS Benchmark Elevation Form will include date, time, weather, problems, repairs and comments.

In the event that the accuracy of the GPS does not meet the requirements of the FSP, a licensed surveyor may be required for increased accuracy. The surveyor will be licensed in the State of Idaho. Data collected by the surveyor will be provided in an electronic format.

4.7.6 Soil Classification

Soil will be described in general accordance with the Unified Soil Classification System (USCS) and the American Standards Testing Method (ASTM) Standard D 2488 - 90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure; ASTM, 1990). A detailed description of soil classification that includes the information listed below is described in detail in SOP-7.

Field observations of soil classification and other observations will be recorded on field sheets such as Soil Boring Logs, Trenching Logs and Soil Sampling Forms located in Appendix A. Information included on the field forms will include the following, as appropriate:

- Group symbol (GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, OL, MH, CH and OH)
- USCS name (silty gravel, silty fine sand, poorly graded sand, etc.)
- Color (Munsell Chart)
- Angularity of coarse-grained soil
- Particle size range and percentage (boulders, cobbles, gravel, sand, fines)
- Plasticity (non-plastic, low, medium, high)
- Density (for clay, silt and sand)
- Moisture content (dry, moist, wet)
- Noticeable odors (if any)

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- Structure (stratified, laminated, fissured)
- Hardness of coarse particles
- Cementation (if present)
- Dry strength (none, low, medium, high, very high)
- Dilatancy (none, slow, rapid)
- Toughness (low, medium, high)
- Minerals (if present)
- Graphic log of bedding, changes of soil type, fractures, organics such as roots and the location of other physical features
- Reaction with HCl (none, weak, strong).

4.7.7 Photo Logs

Photographic records of core samples, test pits, and general field activities shall be collected. Photographic records may also be requested by the FTL to back up soil logging activities or to support the description of surface and subsurface features. Photographic records may be acquired using a digital cameras. A separate bound field logbook (see Section 6.1 for instructions on the use and control of field logbooks) shall be assigned to each camera for recording the photographer's name, subject matter, borehole identification number, interval, and other pertinent information for each frame or digital image. An engineer's scale or tape and standard Munsell/Geological Society of America soil or rock color reference charts shall be included in any photographs taken of soil core. Any wasted frames or images in a roll of film or sequence of digital images shall be so noted in the field logbook.

Photographic records using film will be converted to digital .jpg format. Digital camera images will also be saved in .jpg format. Copies will be saved onto recordable CD or DVDs and will be retained as project records, along with the backup copies of the associated field logbook entries

4.8 SAMPLE TESTING QUALITY ASSURANCE

The samples will be tested for the properties presented in Table 3-2 by IGES. All testing will be in accordance with industry standards as specified in Table 3-2, such as ASTM or other applicable industry standards.

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5.0 HEALTH AND SAFETY PLAN

The FMC OU is covered by the *Site-Wide Health and Safety Plan* (*SWHASP*, FMC, 2013). The SWHASP provides the Site health and safety organization, specific Site hazards, Site controls, Site evacuation procedures, Site PPE requirements, general health and safety procedures, and emergency procedures. In addition, the SWHASP requires that all Contractors working on the Site will develop their own action-specific Health and Safety Plan (HASP) which will incorporate the general requirements specified in the SWHASP. Each Contractor's action-specific HASPs must provide specific health and safety requirements that are pertinent to the anticipated activities during that action.

Per the requirements of UAO Section IX, Paragraph 30. a., FMC will submit the most recent version of the SWHASP under a separate transmittal. Copies of the SWHASP and all Contractor action-specific HASPs will be maintained on Site during actions performed under this Work Plan.

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6.0 DELIVERABLES AND SCHEDULE

In addition to this Plan and the SWHASP (as described in Section 5.0), a report entitled *Data Gap Investigation Report* will be provided within 45 days of completion of the field work or receipt of final material testing report(s) from laboratory, whichever is later.

The overall data gap investigation project schedule is as follows:

Project Activity	**Schedule**
Submittal of the *Site-Wide Health and Safety Plan*	45 days after EPA approval of Supervising Contractor (per UAO Appendix C).
Submittal of *Remedial Design Data Gap Work Plan*	Concurrently with Gamma Cap Performance Evaluation Work Plan
Begin Data Gap Field Investigation	10 days after final approval of the *Remedial Design Data Gap Work Plan.*
Complete Data Gap Field Investigations	30 days after initiation of investigation.
Submittal of the *Data Gap Investigation Report*	45 days after completion of the field investigations or receipt of final material testing report(s) from laboratory, whichever is later.

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7.0 REFERENCES

EPA, 1986. Superfund Remedial Design and Remedial Action Guidance, OSWER, 1986.

EPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act, 1988.

EPA, 1998. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA/540/G-89/004, U. S. EPA, October 1998.

EPA, 2012. Interim Amended Record of Decision. Prepared by the Office of Environmental Cleanup, EPA Region 10, September 27, 2012.

EPA, 2013. Unilateral Administrative Order for Remedial Design and Remedial Action, U.S. EPA, June 10, 2013.

FMC, 2012. Site-Wide Health & Safety Plan, FMC Pocatello Site, Pocatello, Idaho, FMC Corporation, April 2013.

MWH, 2009b. Comparison of Conventional and Alternative Cover Systems for Use at the FMC Plant OU – June 2009 (*Capping Memo*), MWH Americas, Inc.

MWH, 2010. Supplemental Feasibility Study Report for the FMC Plant OU, MWH Americas, Inc., March 2010.

SSSA, 1996. Sparks, D. L., Page, A.L., Helmke, P. A., Loeppert, R.H., Soltanpour, P.N, Tabatabai, M. A., Johnson, C.T., and Sumner, M. E., eds.; Methods of Soil Analysis, Part 3, Chemical Methods, Book Series 5, Soil Science Society of America, Madison, WIs, 1996.

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APPENDIX A

STANDARD OPERATING PROCEDURES (SOPs)

SOP-1 Site Access and Clearance
SOP-2 Equipment Decontamination
SOP-3 Location and Topographical Survey
SOP-4 Investigation-Derived Wastes
SOP-5 Soil Boring and Drilling
SOP-6 Trenching and Test Pits
SOP-7 Soil Classification

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

This SOP has been revised from SOP No. 1 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

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1.0 INTRODUCTION

This standard operating procedure (SOP) defines minimum requirements that shall be fulfilled by all personnel in order to obtain site access and clearance(s) necessary to perform assigned tasks at FMC. It is the Contractor’s responsibility to determine necessary clearances. Access and clearances required may include, but are not limited to, the following:

- Site access and clearance: FMC Project Manager
- Digging, Drilling, Excavation: FMC and/or FMC’s contractor for FMC-owned property and Idaho Dig Line for off property locations (not anticipated).
- Public Road Closure: Idaho Department of Transportation

- Union Pacific Railroad where digging, drilling, or excavations are near the active Union Pacific Railroad tracks.

Close attention shall be paid to minimum waiting periods required before certain authorizations and clearances can be issued. Proper documentation shall be maintained at all times as evidence that authorization/clearance has been obtained. The minimum requirements for the above list are specified in this SOP. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor’s action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

2.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional

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personnel may be involved as needed. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible for ensuring all personnel, including sub-contractors, have the applicable authorization(s) and clearance necessary to perform tasks as assigned. The RDRA Project Manager shall coordinate with other key project staff and FMC personnel to accomplish this task.

Field Team Leader (FTL): Responsible for ensuring access requirements are observed by field personnel at all times, preparing daily logs of field activities, and ensuring that documentation of all appropriate authorization(s) and clearance are at the work site at all times.

Field Technician (or other designated personnel): Assists the FTL with the implementation of field tasks.

3.0 ACCESS TO FMC-OWNED PROPERTY

The entrances to the FMC-owned property will normally be locked at all times. Entry onto the Site will be performed in accordance with the FMC Site-Wide Health and Safety Plan Section 5.1. RDRA contractors and subcontractors will have access to the gate key or code based upon approval and coordination with the RDRA Field Team Leader (FTL) and/or the RDRA Project Manager. All other contractors and/or visitors must obtain approval from FMC and schedule arrival and departure dates/time with FMC at the FMC Pocatello office.

All RDRA contractor and subcontractor employees performing work at the FMC Plant OU will be required to check in and check out with the FTL through the use of a sign-in sheet. A daily field log and sign in sheet will be kept at the work site by the FTL that will

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document all on site personnel and visitors. Persons not meeting the minimum standards as defined in SWHASP will not be allowed access by the FTL.

4.0 HOT WORK CLEARANCE

All cutting, welding, brazing, and other hot work will comply with all safety requirements of FMC SWHASP and the Safety, Fire Prevention and Health (AFOSH) Standard 91-5, OSHA 1910.252, and the National Fire Protection Agency (NFPA) codes.

Under this standard, personnel or contractors involved in RDRA activities that require welding, cutting, brazing, or other "hot work" shall fulfill the following requirements:

1. The RDRA contractor shall contact the FMC and the FTL prior to performing any hot work. This will allow the appropriate review and inspection of the work area prior to cutting, welding, brazing, or other "hot work". As the FMC Plant OU is expected to be fully decommissioned at the time of the RDRA field work, each case will be reviewed for potential hazards or other safety concerns. After such review, written approval (e.g., documented in the site log book) must be obtained from the FTL prior to any RDRA contractor performing hot work on the site.
2. Provide adequate number of portable fire extinguishers and place them as close to the work area as possible.

5.0 UTILITY CLEARANCE ON FMC-OWNED PROPERTY

Underground and aboveground utility clearance will be completed before subsurface investigations commence on FMC-owned property (including obtaining an excavation permit consistent with the requirements of Section 3.2.8 of the SWHASP) or off property (see Section 6 and 7 for requirements pertaining to investigations on lands not owned by FMC). The area within a 5-foot radius of each subsurface sampling location will be cleared using the following protocol:

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1. Review available facility utility maps provided by FMC and/or FMC's contractor, A&E Engineering.
2. Mark the proposed sampling locations and the utility lines in the immediate vicinity using a marker, stake, flags, or paint.
3. Verify proposed sampling locations with FMC plant or A&E employees with knowledge of the utilities to discuss undocumented utilities, potential obstructions, etc.
4. Scan the surface with a magnetic locator according to the manufacturer's directions to search for the presence of buried utilities and other obstructions.
5. Hand auger or push a probe to a depth of 4 to 5 feet below ground surface in areas where historic maps or historic knowledge of subsurface utilities are not available.
6. Overhead telephone and power lines shall also be taken into account when selecting drilling/excavation locations.
7. The RDRA contractor shall notify FMC and A&E in case of any suspicion or confirmation of damage to any underground utilities.

6.0 UTILITY CLEARANCE ON LANDS NOT OWNED BY FMC

Although subsurface investigation is not expected off FMC-owned property as part of the scope of this RDRA, the Idaho Dig Line provides one central location for contractors and the general public to call and notify multiple utility companies of intended excavation (off FMC-owned property). Information, contractor responsibilities, and an online tool to notify Idaho Dig Line of planned work can be found by calling 800-342-1585. Idaho Dig Line shall be notified at least 48 hours, but no more than seven (7) days, prior to drilling or excavation. Notices of drilling or excavation are good for 14 calendar days. Requests for a utility meeting with locators are scheduled through the Idaho Dig Line. If drilling or excavation on a single project lasts more than 14 days, Idaho Dig Line shall be notified prior to the deadline to update clearance permits. To obtain clearance for any drilling or excavation off FMC-owned property, MWH and/or its RDRA subcontractor shall provide Idaho Dig Line with the following information:

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- Company information including company name, address, and telephone number
- The name and telephone number of the caller
- Type of work to be accomplished including information regarding anticipated depth and information regarding horizontal or vertical boring
- Date of proposed work
- Precise location of the proposed drilling/excavation site. This shall be a detailed description including street address, street names and numbers, subdivision lot number if available, direction and distance relative to street or intersection (north, south, east, or west), and any other relevant information. If possible, the site shall be pre-marked with white paint, stakes, or flags
- Provide a location map if requested by Idaho Dig Line
- Marking instructions (e.g., portion of site to be cleared by Idaho Dig Line)
- Field personnel contact name and telephone number

If subsurface investigation is required off FMC-owned property, the RDRA contractor/excavator shall work with MWH to provide this information. MWH shall obtain a Location Request Number from the Idaho Dig Line representative. This is a number that references the caller with the details of the proposed excavation and is helpful when contacting a member utility or Idaho Dig Line for further assistance. MWH and the RDRA subcontractor shall possess this number at all times on job sites to prove compliance with state statutes.

After Idaho Dig Line and local utilities have marked the proposed drilling or excavation site, a minimum clearance of five feet will be maintained between a marked and unexposed underground facility and the cutting edge or point of any power-operated excavating or earth moving equipment. If excavation is required within five feet of any marking, the excavation shall be performed utilizing a hand auger or probe point to check for underground utilities. MWH or the subcontractor shall notify FMC and the Idaho Dig Line in case of any suspicion or confirmation of damage to the underground utilities.

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Underground utilities are marked with paint or pin flags with a color scheme representing different utilities. The way that these lines will be identified by the various utilities are defined by the following legend:

Red = Electric

Yellow = Oil and Gas

Orange = Communications including Cable TV, telephone and fiber optics.

Blue = Water

Green = Sewer

Pink = Temporary Survey Markings

White = Proposed Excavation

7.0 PUBLIC ROAD CLOSURE

Although not expected as part of the scope of this RDRA, the Idaho Department of Transportation (IDOT) requires road/lane closures for all work conducted on designated highways, or shoulder areas of designated highways, within the state of Idaho. This includes, but is not limited to, drilling and excavation and other work to be performed along roadways and shoulders. In such a case, it is the responsibility of MWH to contact IDOT for any authorizations. The following information must be submitted with the application:

- Applicant's name, address and phone
- Reason for permit
- Location of work site, including highway number, city, county, milepost or description
- Anticipated commencement and completion of construction/work
- Instructions for new utility installations
- A map of the work area if possible
- A diagram of the type of road closure signs required
- A name and address of the personnel who will close the lane/road

A performance bond may be required by IDOT prior to commencement of work on IDOT property.

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STANDARD OPERATING PROCEDURE 2

EQUIPMENT DECONTAMINATION

This SOP has been revised from SOP No. 3 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURES 2

EQUIPMENT DECONTAMINATION

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1.0 INTRODUCTION

Decontamination of drilling, sampling equipment, monitoring/inspection equipment and support vehicles at the FMC site is a necessary and critical aspect of environmental field investigations. Proper decontamination is a key element in reducing the potential for cross-contamination between samples from different locations, ensuring that samples are representative of the sampled materials, as well as health and safety issues associated with elemental phosphorus. Improper decontamination may result in costly re-collection and re-analysis of samples. All equipment used in the sampling process shall be properly decontaminated prior to the collection of each sample and after completion of sampling activities.

The procedures outlined in this standard operating procedure (SOP) shall be followed during decontamination of field equipment used in the sampling process, including drilling, soil/water sample collection, and monitoring/inspection activities. Any deviations from these procedures shall be noted in the field logbooks and approved by the RDRA Project Manager and the Quality Manager. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

Three major categories of field equipment, along with applicable decontamination methods for each, are discussed below.

2.0 DEFINITIONS

Brass Sleeve: Hollow, cylindrical sleeves made of brass and used as liners in split-spoon samplers for collection of undisturbed samples.

Auger Flight: An individual hollow-stem auger section, usually 5 feet in length.

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Continuous Core Barrel: 5-foot long steel barrels that can be joined together to allow continuous cores to be collected during a single run.

Drill Pipe: Hollow metal pipe used for drilling, through which soil and groundwater sampling devices can be advanced for sample collection.

Potable Water: A drilling quality water source that can be used for steam cleaning and decontamination water. This source should be sampled at the beginning of each field program to set baseline concentrations.

Distilled Water: Commercially available or laboratory-grade water that has been distilled. Each batch of distilled water should be analyzed to set baseline concentrations. The distilled water will be used as rinse water during the decontamination of tools, sampling equipment and other small items.

Hand Auger: A sampling tool consisting of a metal tube with two sharpened spiral wings at the tip.

Split-Spoon Sampler: A sampling tool consisting of a thick-walled steel tube with a removable head and drive shoe. The steel tube splits open lengthwise when the head and drive shoe are removed.

Scoop: A sampling hand tool consisting of a small shovel- or trowel-shaped blade.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-

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specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Selects project-specific drilling and sampling methods, and associated decontamination procedures with input from other key project staff and other personnel that are responsible for project quality control.

Quality Manager: Performs project audits. Ensures project-specific data quality objectives are fulfilled.

Field Team Leader (FTL) and/or Geologist, Hydrogeologist, or Engineer: Implements the field program and supervises other sampling personnel. Ensures that proper decontamination procedures are followed. Prepares daily logs of field activities.

Field Sampling Technician (or other designated personnel): Assists the FTL, geologist, hydrogeologist, or engineer in the implementation of tasks and is responsible for the decontamination of sampling equipment.

4.0 DECONTAMINATION PROCEDURES

A decontamination pad designed to collect the rinsate and any associated soil or chemicals will be established in a location at the FMC site. The decontamination pad will be constructed in an area designated by FMC and will be used for the duration of the field activities. The decontamination pad will be large enough to accommodate the drilling equipment components that come into contact with contaminated soils or groundwater that are present at the site. The rinsate collected from the decontamination pad and from other onsite decontamination activities will be stored in labeled containers until the proper disposal protocol is established pending waste characterization.

Soil boring drilling and soil sampling procedures require that decontaminated tools be employed in order to prevent cross-contamination. The decontamination procedures

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described below shall be followed to ensure that only uncontaminated materials will be introduced to the subsurface during drilling and sampling. For equipment and tools that have come into contact with contaminated soils or groundwater, the equipment decontamination process shall be undertaken before and after each use of the equipment and shall include washing. The flooring of the decontamination pad shall be impermeable to water and have a sump or low area to collect the rinsate to be transferred into the storage containers.

The precise location of the decontamination facility shall be determined based on such factors as ease of access for personnel and proximity to work site and rinsate storage or staging areas.

4.1 DRILLING AND LARGE EQUIPMENT

4.1.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment and support vehicles in areas of the Site in which there is a potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). This will include percussion hammer drill pipe, hollow-stem auger flights, drill rods for sampling, the drill rig, support vehicles and other equipment and tools that may come in contact with sampling equipment or that may have possible contamination.

- Wash the external surfaces and internal surfaces, as applicable, on equipment using water from an approved water source. If necessary, scrub using a phosphate-free detergent (e.g., Alconox™), or equivalent laboratory-grade detergent until all visible dirt, grime, grease, oil, loose paint, rust, etc., have been removed.
- Rinse with potable water.

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4.1.2 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment, trenching equipment, construction equipment, and support vehicles in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). Note that this procedure will apply to equipment that comes into contact with native soils and/or slag on slag covered roads or surfaces. For example, trenching in the Western Undeveloped Area and/or construction of the test gamma cap will involve drilling, trenching, digging, or construction activities in areas where the large equipment will only contact native soils and slag on roads and/or construction surfaces.

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing tires and other surfaces that came into contact with native soils or slag.

4.2 SOIL AND GROUNDWATER SAMPLING/INSPECTION EQUIPMENT

4.2.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedure will be used to decontaminate sampling/inspection equipment such as split-spoon samplers; brass sleeves; continuous core barrels; scoops; hand augers; metal sampling pans; video equipment and other sampling/inspection equipment and tools that may come into contact with contaminated soils and/or groundwater.

- Wash and scrub equipment with phosphate-free, laboratory-grade detergent (e.g., Alconox™ or equivalent); steam cleaning may also be performed if possible.
- Double or Triple-rinse with potable water.
- Air dry.
- Store in clean plastic bag or designated casing.

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Personnel involved in decontamination activities shall wear appropriate protective clothing as defined in the project-specific health and safety plan.

4.2.2 In Areas with Potential Contact with Elemental Phosphorus

The following procedure will be used to decontaminate sampling/inspection equipment such video equipment and/or sampling equipment and tools that may come into contact with site materials contaminated with elemental phosphorus (P4). The only activity where potential P4 exposure is expected is while video surveying the storm sewers in RA-A. Special health and safety precautions for the storm sewer video survey include:

- Persons involved in the video survey of the RA-A storm sewers should read and be familiar with the hazards of P4 exposure as presented in Section 3.1.3 of the SWHASP. Note that the immediate area around the location where the storm sewer video survey is being performed shall be designated an *Exclusion Zone* as discussed in Section 6.1.1 of the SWHASP.
- Persons involved in the video survey of the RA-A storm sewers, performing decontamination, and within the *Exclusion Zone* shall don ***Modified Level C Protection for Potential Phosphorus Exposure*** as discussed in Section 7.3.3 of the SWHASP.
- A water-filled washtub (or similar container) of sufficient size to contain the camera and wiring shall be immediately available to place equipment or PPE which may spontaneously combust due to the presence of P4.

As the camera and wiring is removed from the storm sewers, the following decontamination procedures will be applied:

- Wash and scrub equipment with water as the camera and wiring is withdrawn from the sewer piping, taking care to only handle the cleaned portion of the equipment (while wearing the ***Modified Level C Protection for Potential Phosphorus Exposure***).
- Double or Triple-rinse with potable water.

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- Capture all wash and rinse water in a metal container for later waste determination.
- Air dry the camera and wiring until completely dry. This will allow any remaining P4 to oxidize prior to stowage.

4.2.3 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of sampling equipment including in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring).

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing surfaces that came into contact with native soils or slag.

4.3 GROUNDWATER MONITORING EQUIPMENT

The following procedure shall be used to decontaminate groundwater monitoring devices such as groundwater elevation meters and free product thickness meters. Spray bottles may be used to store and dispense distilled water.

- Wash equipment with laboratory-grade, phosphate-free detergent (e.g., Alconox™ or equivalent) and water, or steam clean.
- Triple-rinse with distilled water.
- Store in clean plastic bag or storage case.

5.0 PROCEDURE FOR OTHER WASTE DISPOSAL

While the decontamination Investigative Derived Waste (IDW) will be evaluated on a case-by-case basis, the general approach to be followed is detailed in SOP-7.

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Decontamination fluids (typically washwater) will be contained as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad or within the collection container). Washwater will then be containerized to await waste determination. Solids will also be containerized in a separate container to await waste determination.

6.0 REFERENCES

Environmental protection Agency, RCRA Ground-Water Monitoring: Draft Technical Guidance, November 1992. Page 7-17.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

This SOP has been revised from SOP No. 6 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

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1.0 INTRODUCTION

Surveying is the science of making the measurements necessary to determine the relative positions of points above, on, or beneath the surface of the earth, or to establish such points. This standard operating procedure (SOP) provides a description of the general types of surveys and requirements for performing these surveys. This SOP describes the applicability of the Global Positioning System (GPS) surveys, along with precision and accuracy required for each technique. This SOP is intended for the project leader to help develop work plans and manage resources. Note that in addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) while working on Site.

2.0 DEFINITIONS

Accuracy: Accuracy refers to the closeness between measurements and expectations or true values. The farther a measurement is from its expected value, the less accurate it is. Observations may be accurate but not precise if they are well distributed about the expected value, but are significantly disbursed from one another.

Accuracy is often referred to in terms of its order (i.e., first, second, or third order accuracy). The order of accuracy refers to the error of closure allowed; guidelines for each order of accuracy are as follows:

Order of Accuracy	Maximum Error
1st	1/25,000
2nd	1/10,000
3rd	1/5,000

Benchmarks: Monuments placed by surveyors to serve as permanent reference points. Benchmarks are elevation markers, and their location and elevation are precisely established and recorded on surveyors' level notes. They are set upon some permanent object to ensure they remain undisturbed.

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Global Positioning System (GPS): This system utilizes a network of overhead satellites orbiting the earth to locate objects and/or targets on the surface of the earth. Data from a minimum of three satellites is required to plot (by triangulation) the location of a certain point. Accuracy is dependent on the duration of data collection and the type of receiver/antenna used. All measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988.

Monuments: Physical objects that serve as landmarks for navigation. Classes of monuments include: natural, artificial, record, or legal. Examples of natural monuments are trees, large stones, or other substantial, naturally occurring objects in place before the survey was made. Artificial monuments can consist of iron pipe or bar driven into the ground, concrete or stone monument with a drill hole, cross, or metal plug marking an exact location (such as a corner). The standard for monumenting public-land surveys, as adopted by the Bureau of Land Management (BLM), is a post made of iron pipe filled with concrete. The lower end of the pipe is split and spread to form a base and the upper end is fitted with a brass cap with identifying marks. A record monument exists because of a reference in a deed or description (e.g., the gutter along a street). A legal monument is one that is controlling in the description (e.g., "to a concrete post").

Precision: Precision pertains to the distribution over a set of repeated observations of a random variable. It is a measure of the reproducibility of a result or measured value. Thus, if observations are closely clustered together, then the observations are said to have been obtained with high precision. Observations may be precise but not accurate if they are closely grouped about a value that is different from the expected or true value.

Station: A station is a 100-foot section of a measurement from a reference point such as a benchmark. For example, a stake placed 1,500 feet from a reference point is at station 15 and is labeled "15+00," and a stake placed 1,325 from a reference point is labeled "13+25."

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3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: The RDRA Project Manager has overall responsibility for establishing the specific technical requirements and coordinating the survey services for the project. The RDRA Project Manager shall rely on input from FMC personnel and other key project staff who may have more detailed knowledge of the technical requirements and who would be on site to oversee the surveying. To facilitate the management and administration of surveying services procured for a particular site, the RDRA Project Manager may delegate responsibility to the Field Team Leader (FTL) as the focal point for all matters involving surveying services.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Responsible for implementation of the actual field activities performed on site including the measurement of sampling locations and to daily check the accuracy of the GPS instrument. In addition, the FTL shall be responsible for scheduling and coordinating field activities, overseeing survey activities, and preparing daily logs of field activities.

Surveyor (Surveying Contractor): In the event a licensed land surveyor is needed, the surveyor will be responsible for assuring that all surveying field operations, office calculations, map preparation, and related surveying activities conform to established guidelines and the specific requirements of the surveying subcontract (including health and safety requirements). All surveying operations shall be performed by, or under the direction of, a State of Idaho Licensed (or Registered) Land Surveyor, who shall sign and seal all final drawings, maps, and reports submitted as deliverables.

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4.0 GUIDELINES

The following sections provide guidelines for the performance of several types of surveys and the precision and accuracy required for each. Emphasis is placed on the application of surveying techniques to environmental investigations.

4.1 PERFORMING SURVEYS

There are many types of surveys that can be performed. This SOP describes the survey that will potentially be used at the FMC site. The survey will be used to establish northing and easting measurements and an elevation (feet above mean sea level). A Sokkia Axis, Trimble GEO Explorer, Trimble Pathfinder GPS or similar unit will be used for mapping test pits, boreholes, PIC and other sampling locations as well as being used for determining the thickness of soil covers. The selected unit must have an accuracy of 1 meter or less and will be checked daily with a known elevation of a benchmark. If the accuracy is greater than 1 meter, than the type of location data will be evaluated as to whether a professional surveyor is required. All measurements will be referenced to a State Plane Coordinate System, North American datum 1983 and the North American Vertical Datum 1988.

Global Positioning System (GPS) Surveying: GPS is a ranging system from known positions of satellites in space to unknown positions on land, sea, and in air or space. GPS uses the triangulation from orbiting satellites to establish the location derived from the broadcast of a satellite signal. The GPS unit measures the distance using the travel time of radio signals. The GPS concept assumes that four or more satellites will be available at any location on earth 24 hours a day.

Establishing Control (Benchmark): Prior to initiating any type of survey, a control shall be established at the site. The control point will be a surveyed benchmark used as a daily check for the accuracy of the GPS unit. If a benchmark is not available at the site or if access is limited, a fixed monument may be established by a licensed surveyor.

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Licensed Surveyor: In the event that a licensed surveyor is required for increased accuracy a State of Idaho Licensed Surveyor will be used at FMC. In the State of Idaho, the Idaho State Government Department of Commerce, Division of Occupational and Professional Licensing, administers licensing and certification programs.

Based on the project requirements, monuments may be set at the site that can be used in future site-surveys as a control point. Care shall be taken when establishing new control points and elevations from other agencies' vertical control points to ensure that all the old control benchmarks are on the same datum or reference plane. The monument shall be stamped with the state planar coordinates and the elevation (feet above mean sea level) such that it shall serve as a reference point for additional surveys. This can save time in future survey work as the surveying contractor will not have to survey new locations from distant established control points.

4.2 REQUIRED ACCURACY AND PRECISION

The required survey accuracy and precision depends on the intended purpose of the survey work. Sampling locations are to be surveyed within 1 meter or less both horizontally and vertically. Higher accuracies may be required for boundary surveys, topographic surveys, etc. The following sections discuss accuracy and precision requirements for specific survey types.

Marking Sampling Locations: The sampling location will be marked in the field using a stake with the corresponding sample number in the event that the location is revisited for additional sampling or surveying.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE MANAGEMENT

This SOP has been revised from SOP No. 7 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT

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1.0 INTRODUCTION

Investigation-derived waste (IDW) may be generated during the field investigation activities conducted under the planned performance evaluation and data gap investigations at the FMC Plant Operable Unit during 2013. The National Contingency Plan (NCP), codified in 40 Code of Federal Regulations (CFR) 300, requires that IDW be handled to attain all the applicable or relevant and appropriate requirements (ARARs) to the extent practicable, considering the urgency of the situation. The purpose of this SOP is to present procedures to be followed in the management of IDW generated during these field activities.

Potential IDW that may be generated during field activities are solid wastes and may include (but are not limited to) the following media and waste types:

Fluids	Solids
Groundwater well development / purge	Soils and soil cuttings
Drilling mud	Plastic tarps or sheeting
Grout	Drill pipe and well casing/screen
Decontamination fluids and wastewater	Decontamination solids
	Disposable equipment (i.e., rope, bailers, sampling equipment, & other consumables)
	Spent personal protective equipment (PPE)
	Used containers, sample bottles
	Packaging materials

The above wastes may or may not be encountered, generated or managed while performing the 2013 field activities. However, all solid waste streams will be characterized to determine if they are hazardous wastes per 40 CFR § 262.11 for the purposes of handling and disposal. Guidance from this document shall be used as part of project planning to estimate total volumes of IDW likely to be generated during the anticipated 2013 field activities as well as how the IDW will be managed and disposed.

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2.0 DEFINITIONS

Area of Contamination (AOC) unit: The AOC unit concept is critical to the IDW management at a CERCLA investigation site. Although EPA has not promulgated a definition of an AOC unit, an AOC unit is generally an area within a CERCLA investigation site with similar characteristics with respect to contamination and the associated risks to human health and the environment. A CERCLA investigation site may contain one or more AOC units. AOC units for the FMC Plant Operable Unit, which may be different from the Remediation Units (RUs) as used in the *SRI Work Plan for the FMC Plant OU* and/or the Remediation Areas (RAs) used in the *SFS Report for the FMC Plant OU*, will be delineated based upon exiting information, information gathered during the SRI, and visual observation as well as consideration of IDW management.

Decontamination fluids: Any fluids, including aqueous wash water, solvents, and contaminants that are used or generated during decontamination procedures.

Decontamination solids: Any solids, including soils and soil cuttings, fill materials, and contaminants that are generated during decontamination procedures.

Grout: A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed as required.

Hazardous waste: A solid waste that meets the definition of a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Hazardous IDW: An investigation derived waste that is also a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Investigation-derived waste (IDW): Solid wastes, as defined in 40 CFR § 261.2, directly generated as result of performing the 2013 field activities at the FMC Plant OU.

Nonhazardous waste: A solid waste that does not meet the definition of a hazardous waste as defined in 40 CFR § 261.3 or is excluded from hazardous waste regulation per 40 CFR § 261.4(b).

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Soils and soil cuttings: Solid material generated from excavation or drilling processes. Soils may include native soils, fill materials, and/or other historical plant waste streams used as fill materials on the site.

Solid waste: Any waste stream (solid, liquid or containerized gas) that meets the definition of solid waste under RCRA as defined in 40 CFR § 261.2.

3.0 RESPONSIBILITIES

This section presents a brief definition of the field team roles and responsibilities for management of IDW generated while conducting the 2013 field activities. This list is not intended to be a comprehensive list as additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible to ensure that all field team members are properly trained per their responsibilities associated with IDW and that appropriate equipment and facilities are available for appropriate IDW management.

Field Team Leader (FTL): Implements the field program and supervises all field team members in the appropriate management of IDW. Ensures that only properly trained personnel are managing IDW on the site.

Environmental, Health and Safety (EHS) Officer: Assists the Field Team Leader in the supervision of all IDW management on site. The EHS officer shall be responsible for all IDW identification and characterization, on site disposal, off site shipment and disposal, waste accumulation, emergency response and contingency planning, IDW training, and IDW reporting and recordkeeping.

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Project Team Members: Ensure that they are properly trained prior to any IDW management as well as follow the appropriate IDW procedures and training.

4.0 REGULATORY BASIS AND GUIDANCE

IDW encountered, generated, or managed during the 2013 field activities may contain hazardous substances as defined by CERCLA. Some IDW may be hazardous wastes under RCRA while others may be regulated under other federal laws such as TSCA. These regulatory requirements may be applicable or relevant and appropriate requirements (ARARs) which impact how the IDW is managed. Note that hazardous wastes under RCRA and/or wastes regulated under TSCA are not expected to be encountered, generated, or managed as part of the 2013 field activities. However, waste determinations will be performed and documented on all waste streams.

4.1 EPA GUIDANCE ON IDW MANAGEMENT

The management of IDW generated during the 2013 field activities shall be in accordance with EPA Guidance "Management of Investigation-Derived Wastes During Site Inspections", May 1991 (EPA, 1991). This guidance is based upon EPA's strategy for managing IDW based upon the following concepts:

- The National Contingency Plan (NCP) directive that CERCLA site investigations (SI) comply with applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

- The Area of Contamination (AOC) unit concept.

The specific elements of EPA's guidance for IDW management are as follows:

- Characterizing IDW through the use of existing information (manifests, MSDSs, previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgement.

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- Delineating an AOC unit for leaving RCRA hazardous soil cuttings within the unit.

- Containerizing and disposing of RCRA hazardous groundwater, decontamination fluids, PPE, and disposable equipment at RCRA Subtitle C facilities.

- Leaving on-site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids preferably without containerization and testing.

In general, EPA does not recommend removal of wastes from sites, in particular, from those sites where IDW do not pose any immediate threat to human health or the environment. Actions taken during the 2013 field activities with respect to IDW, that leave conditions essentially unchanged, should not require a detailed analysis of ARARs or assurance that conditions at the site will comply with the ARARs. At the same time, field personnel conducting the 2013 field activities should ensure that their handling of IDW does not create additional hazards at the site.

In brief, compliance with the NCP can generally be assured by:

1) Identifying contaminants, if any, present in the IDW based upon existing information and best professional judgement; testing is not required in most circumstances.

2) Determining ARARs and the extent to which it is practicable to comply with them.

3) Delineating an AOC unit based upon existing information and visual observation if soil cuttings are RCRA hazardous.

4) Burying RCRA hazardous soil cuttings within the AOC unit, so long as no increased hazard to human health and the environment will be created. Containerization and testing are not required.

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5) Containerizing RCRA hazardous groundwater and other RCRA hazardous IDW such as PPE, disposable sampling equipment, and decontamination fluids for off-site disposal.

4.2 HAZARDOUS WASTE REGULATION

The RCRA hazardous waste regulations are clearly ARARs for hazardous IDW generated and managed during the 2013 field activities. However, with the application of EPA IDW guidance, RCRA requirements apply to management of IDW in the following manner:

- If RCRA hazardous IDW is stored or disposed off-site, then comply with all RCRA (and other ARAR) requirements.
- If RCRA hazardous IDW is stored on-site, then comply with RCRA (and other ARAR) requirements to the extent practicable.

For the 2013 field activities, the following general guidance is expected to be practicable and therefore followed, recognizing that each situation will be evaluated against EPA IDW guidance (EPA, 1991) as well as RCRA hazardous waste requirements and other ARARs:

- IDW may be assumed not to be a "listed" hazardous waste under RCRA 40 CFR 261 Subpart D, unless available information about the site suggests otherwise.
- IDW characterization to determine if the IDW exhibits RCRA hazardous waste characteristics do not typically require testing if the characterization can be made by "applying knowledge of the hazardous characteristics in light of the materials or processes used" or by historical testing consistent with 40 CFR § 262.11(c).

- Compliance with the RCRA hazardous waste generator requirements of 40 CFR Part 262 for all RCRA hazardous IDW generated and/or managed (with exception of soil cuttings managed in accordance with the EPA IDW guidance). It is presumed that the RCRA hazardous IDW generated will fall within the large quantity generator (LQG) requirements.

- Land disposal does <u>not</u> occur (and thus the Land Disposal Restrictions [LDR] of 40 CFR Part 268 are <u>not</u> applicable) when IDW soil cutting wastes are:

  – Moved, stored or left in place within a single AOC unit;
  – Capped in place;
  – Treated in situ (without moving the IDW to another AOC unit for treatment); or
  – Processed within the AOC unit to improve structural stability (without placing the IDW into another AOC unit for processing).

- Conversely, land disposal <u>does</u> occur (and the LDR of 40 CFR Part 268 <u>are</u> applicable) when IDW soil cutting wastes are:

  – Moved from one AOC unit to another AOC unit for disposal;
  – Moved outside an AOC unit for treatment or storage and returned to the same AOC unit for disposal;
  – Excavated from an AOC unit and placed in a container, tank, surface impoundment, etc. and then re-deposited back into the same AOC.

5.0 DESCRIPTION OF ANTICIPATED IDW MANAGEMENT

The following subsections provide a description of the anticipated IDW to be encountered, generated, and/or managed at the FMC Plant Operable Unit during the 2013 field activities and the anticipated management of each. It should be noted that this information is provided for planning purposes, and will be evaluated and may need to be revised based upon actual experience and waste determinations while on site.

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5.1 SOIL AND SOIL CUTTINGS

During the 2013 field activities, numerous test pits, trenches, and borings will be performed within the Western Undeveloped Area (WUA) of the FMC Plant Operable Unit to gain access to appropriate depths for soil sampling and to provide a source of clean soil for the test gamma cap. The WUA was determined during the SRI to be un-impacted, therefore, soils from this area will be managed as clean soils. There will also be extraction wells and sampling wells installed at the northeast corner of the FMC Plant OU. In addition to native soils, fill materials including slag and phosphate ore are expected to be encountered. Past analyses of these fill materials have determined that these fill materials do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all soil and soil cuttings managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Leaving on-site RCRA nonhazardous soil cuttings within the AOC where they are generated. Typically, this will involve placing soil cuttings back into the same investigation pit, trench, or bore hole (except finished wells) and in the same order from which the material was removed, to the extent practicable. For example, and effort will be made to segregate fill materials from native soils as soil cuttings are removed from a pit, trench, or bore hole. For finished wells, the soil cuttings will be spread out at the surface near the bore hole. The placement of the soil cuttings back into the pit, trench or bore hole will typically involve placement of the native soils back first, followed by the fill materials. This should ensure that there are not additional hazards created at the site and that site conditions remain essentially unchanged.

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5.2 WELL DEVELOPMENT AND PURGE FLUIDS

During the 2013 field activities, groundwater extraction wells and piezometers are anticipated to be installed in the northeast area of the FMC Plant Site. Fluids will be generated during the development the wells and piezometers and purge water will be generated during the planned pump testing of the extraction wells. Over 20 years of analyses of groundwater from monitoring wells in the proximity of the planned wells / piezometers do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all well development and purge fluids managed during the 2013 field activities will be managed as follows unless field observations are different than expected:

- Containment of well development / purge fluids as generated to await waste determination.

- Characterizing the well development / purge fluids through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The well development / purge liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- Any well development / purge liquids that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

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5.3 SPENT SAMPLING-RELATED EQUIPMENT

During the 2013 field activities, spent sampling-related equipment may be generated. This may include (but not limited to) plastic sheeting/tarps, rope, bailers, sampling equipment, spent PPE, sample bottles, used containers, packaging materials, and other consumables. The spent sampling-related equipment is expected to be nonhazardous, based upon historical and SRI data collected.

While the spent sampling-related equipment will be evaluated on a case-by-case basis, the general approach to be followed for spent sampling-related equipment IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containerizing the spent sampling-related equipment at the point of generation.

- Characterizing the spent sampling-related equipment IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- Those spent sampling-related equipment IDW that are determined to be nonhazardous will be disposed along with other Site non-hazardous solid waste.

- Those spent sampling-related equipment IDW that are determined to be hazardous (although not expected) will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

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5.4 DECONTAMINATION FLUIDS AND SOLIDS

5.4.1 Decontamination Fluids and Solids Associated with Drilling, Digging, and/or Trenching

During the 2013 field activities, decontamination fluids and solids will be generated. Typically, these will be generated at a common decon area, although there may be more than one decon area. Typically, the decontamination IDW will include (but not limited to) washwater from equipment, cleaning agents, cleaning utensils, and spent PPE (along with associated contaminants). Although this decontamination IDW is expected to be nonhazardous, waste determinations will be performed on each waste stream.

5.4.2 Decontamination Fluids and Solids Associated with Sewer Pipe Investigation

Decontamination fluids and solids are expected to be generated during the video inspection of the storm sewers in RA-A. This is the only 2013 field activity in which field equipment is expected to come into contact with site materials contaminated with elemental phosphorus (P4). While the decontamination wash and rinse waters are expected to be non-hazardous, they may contain small amounts of P4.

5.4.3 Decontamination Fluids and Solids Waste Management

While the decontamination IDW will be evaluated on a case-by-case basis, the general approach to be followed for decontamination IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containment of decontamination fluids (typically washwater) as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad). Washwater will then be containerized to await waste

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determination. Solids will also be containerized in a separate container to await waste determination.

- Other decontamination solids such as cleaning utensils and PPE will also be containerized to await waste determination.

- Characterizing the decontamination IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The decontamination solids IDW that are determined to be nonhazardous will be disposed in on-site.

- The decontamination liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- The decontamination IDW (either liquid or solid) that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

6.0 PROCEDURES FOR HAZARDOUS IDW MANAGEMENT

Although hazardous IDW is not expected to be generated, the following procedures apply to all IDW that have been determined to be hazardous except for soil cuttings IDW that remain with the AOC unit.

6.1 INTRODUCTION

Once an IDW has been determined to be hazardous, the federal RCRA Subtitle C waste management requirements apply to that waste. The scope of this procedure covers the

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requirements for large quantity generators of hazardous IDW which manage the hazardous IDW on site such that RCRA permitting is not required.

6.2 DETERMINE LAND DISPOSAL RESTRICTIONS

The 1984 amendments to the RCRA law included a prohibition of land disposal of certain hazardous wastes without first meeting some treatment standards. For the most part, all listed and characteristic hazardous wastes must be treated according to the treatment levels and technologies outlined in 40 CFR Part 268 to reduce the toxicity and/or mobility of hazardous constituents prior to being disposed of on the land, i.e., landfilled. Therefore, a generator must determine if the waste is a "restricted waste" under the land ban rules, and if so, off site treatment and disposal is limited. Note that these rules apply only to wastes destined for land disposal which is defined as: placement in or on the land including a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, underground mine or cave, or concrete vault or bunker. Wastes which are shipped off site for disposal other than land disposal are not regulated under the land disposal restriction regulations of 40 CFR Part 268.

Generators of hazardous wastes must determine if the waste is restricted from land disposal under 40 CFR Part 268. The following reporting and recordkeeping requirements apply.

- If a generator determines that he is managing a restricted waste and the waste does not meet the applicable treatment standards, with each shipment of waste, the generator must notify the treatment or storage facility in writing of the appropriate treatment standards;
- If the generator determines that he is managing a restricted waste and the waste can be disposed without further treatment, with each shipment of waste, the generator must submit to the treatment, storage or disposal facility a notice and certification stating that the waste meets the applicable treatment standards;

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- If the generator determines that he is managing a waste subject to an exemption from a prohibition on the type of land disposal method utilized for the waste, with each shipment of waste, the generator must submit to the receiving facility a notice stating that the waste is not prohibited from land disposal;
- If the generator is managing prohibited waste in tanks, containers, or containment buildings regulated under 40 CFR 262.34, and is treating such waste in such tanks, containers, or containment buildings to meet applicable treatment standards, the generator must develop a waste analysis plan which describes the procedures the generator will carry out to comply with the treatment standards; and
- If the generator determines whether the waste is restricted based solely on his knowledge of the waste, all supporting data used to make this determination must be retained on-site in the generator's files.

The generator must retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to these requirements for at least three years from the date the waste was last shipped from the site. It should also be noted that it is prohibited to dilute a hazardous waste in order to circumvent the land disposal prohibitions (40 CFR 268.3). Once a waste is determined to be a "restricted waste", an appropriate Treatment, Storage, and Disposal Facility (TSDF) can be selected to properly treat and dispose of the waste.

6.3 ON-SITE ACCUMULATION

As discussed in Section 5.0 above for each IDW generated, a large quantity generator (LQG) must make the appropriate hazardous waste determination per 40 CFR Part 262.11. If the IDW is determined to be hazardous, then the IDW will typically be stored on-site prior to shipment off-site for disposal. The following requirements apply to all hazardous IDW being stored on-site prior to shipment.

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6.3.1 EPA Identification Number (40 CFR Part 262.12)

Any facility which is a LQG of hazardous wastes must not treat, store, dispose, transport or offer for transportation any hazardous waste without first obtaining a EPA identification number from EPA (or the authorized state). Hazardous wastes cannot be offered to transporters or to treatment, storage or disposal facilities that have not received a EPA identification number. The FMC Plant Operable Unit has an EPA ID number of IDD070929518 which will be used on all manifests for shipments of hazardous IDW for off-site disposal.

6.3.2 On-Site Hazardous Waste Accumulation (Storage) (40 CFR 262.34(d))

Two types of accumulation areas for hazardous waste are permissible for a LQG without RCRA interim status or a Part B permit. These are the "90-day storage area" and the "satellite accumulation station" (SAS). The SAS requirements are discussed below. With regards to a "90-day storage area", a LQG may store hazardous wastes on-site for up to 90 days or less in a storage area, provided that the following conditions are met:

- If the waste is placed in containers, the requirements of 40 CFR Part 265 Subpart I (container requirements) are met. See below for container requirements;
- If the waste is placed in tanks, the requirements of 40 CFR 265 Subpart J (tank requirements) are met. See below for the tank requirements.
- At closure, the generator closes the storage area per the requirements of 40 CFR 265.111 and 40 CFR 265.114;
- The date which the hazardous waste is placed in the storage area is clearly marked on the container, and the container is clearly marked as "Hazardous Waste";
- The facility complies with 40 CFR Part 265 Subpart C, Preparedness and Prevention (See Section 6.3.3 below);

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- The facility complies with 40 CFR Part 265 Subpart D, Contingency Plan and Emergency Procedures (See Section 6.3.4);
- The facility complies with 40 CFR Part 265.16 training requirements (See Section 6.6 below);
- Any hazardous wastes which are stored longer than 90 days must first be granted an extension by EPA (or authorized state).

<u>90-Day Storage Area Container Requirements (40 CFR Part 265 Subpart I)</u>

Hazardous waste stored in containers must meet the following requirements:

- Containers must be in good condition, free of leaks;
- Hazardous wastes must be compatible with container (or liner) material;
- Containers must always be kept closed except to add or remove wastes;
- Containers must be handled in a manner to avoid ruptures;
- The storage area must be inspected at least weekly to check for container deterioration; and
- Incompatible wastes must be stored separately with separate secondary containment.

Incompatible wastes are wastes that are unsuitable for co-mingling because the co-mingling could result in any of the following:

- Extreme heat or pressure generation;
- Fire;
- Explosion or violent reaction;
- Formation of substances that have the potential to react violently;
- Formation of toxic dusts, mists, fumes, gases, or other chemicals; and/or
- Volatization of ignitable or toxic chemicals due to heat generation.

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90-Day Storage Area Tank Requirements (40 CFR Subpart J)

LQGs that accumulate or store hazardous wastes in tanks or tank systems must meet the following requirements:

- For tanks existing prior to July 14, 1986, an assessment of tank must be performed and certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.191);
- New tank systems (those built after July 14, 1986) must meet tank technical standards and have been certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.192);
- New tank systems must have adequate secondary containment and leak detection systems. Existing tanks must be upgraded to meet these standards by the time the tank is 15 years of age (40 CFR 265.193);
- Tanks must be operated to prevent system failure, overflow and spills. Tanks must be operated with sufficient freeboard to prevent overtopping (40 CFR 265.194);
- Inspect the tanks at least once each operating day for the following:
    - Discharge control equipment;
    - Monitoring equipment and controls;
    - Tank level; and
    - Evidence of leaks or spills. (40 CFR 265.195)
- Inspect the tanks at least weekly for corrosion, erosion or leaks;
    - The tank must meet the closure and post-closure care provisions of 40 CFR 265.197; and
    - Store incompatible wastes separately (40 CFR 265.199).

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Satellite Accumulation Station (SAS) Requirements (40 CFR 262.34(c))

A SAS is a container placed at or near the point of waste generation for the purpose of collecting the waste as it is being generated. For example, a container may be placed in the quality control laboratory for collection of hazardous wastes generated in the laboratory. This SAS may collect up to 55 gallons of hazardous waste or 1 quart of acute hazardous waste. The SAS does not need to meet the requirements of a storage area, provided the following conditions are met:

- The amount of hazardous waste accumulated at the SAS does not exceed 55 gallons (or 1 quart of acute hazardous waste);
- The SAS is located at or near the point of generation where the waste is initially accumulated and is under the control of the operator of the process generating the waste;
- The container used is in good condition, is compatible with the wastes being accumulated, and is kept closed except to add or remove wastes;
- The container is marked with the words "Hazardous Waste" or other words to identify the contents; and
- Once the 55-gallon limit is reached, the date is marked on the container and the container is moved from the SAS within three days to a proper location. For example, the wastes must either be moved to the storage area or be picked up by a waste transporter and moved off-site.

6.3.3 Preparedness and Prevention (40 CFR Part 265 Subpart C)

The following preparedness and prevention steps must be taken concerning the hazardous waste storage area:

- The storage area must be operated and maintained to minimize the possibility of fire, explosions or releases of hazardous waste;

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- The facility must have appropriate communication systems, fire-fighting equipment, spill control equipment and decontamination equipment;
- All emergency response systems and equipment must be tested monthly with documentation and maintained to assure proper operation;
- Persons handling hazardous wastes must have immediate access to alarms and/or communication systems;
- The storage area shall have adequate aisle space for emergency response activities; and
- The facility must attempt to make arrangements with the local police, fire departments, emergency response teams, and local hospitals to assure readiness for potential emergencies associated with the storage area.

6.3.4 Contingency Plan and Emergency Procedures (40 CFR Subpart D)

A LQG that accumulates or stores hazardous waste on site in a 90-day storage area must develop and keep current a contingency plan for the facility. The purpose of the contingency plan is to provide an organized plan of action and delegation of responsibilities and authority to specific facility personnel to respond to emergency situations that may require both the facility and/or outside resources. The contingency plan is designed to minimize hazards to humans or the environment from fires, explosion or any unplanned sudden or non-sudden release of hazardous waste/hazardous waste constituent to air, soil or surface water in compliance with the requirements of 40 CFR 265 Subpart D. MWH will maintain a Contingency Plan on the site if hazardous IDW are accumulated on-site.

The key components of the contingency plan include the following (40 CFR 265.52):

- A description of the emergency response organization, including designation of the Emergency Coordinator and alternates;
- Response procedures;

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- Emergency notification;
- Arrangements with local authorities;
- List of names, addresses and phone numbers of designated emergency personnel and alternates;
- List of emergency response communication equipment and locations;
- Evacuation procedures, routes and alternates; and
- Procedures for amending the plan.

Copies of the plan must be sent to (40 CFR 265.53):

- The FMC Project Manager;
- Power County Sheriff's department;
- Pocatello fire department; and
- Other agencies as deemed appropriate.

The emergency coordinator (EC) is the key person facilitating emergency preparedness and response. The EC or designated alternate shall be on-site or on-call at all times. The EC and alternates must be trained and thoroughly familiar with the contingency plan, emergency response activities and operation of the facility. The EC must know the locations and characteristics of all waste generated, location of all records within the facility and the facility layout. The EC must have the authority to commit the resources needed to carry out the spill response plan. Any person or department who first discovers any spill of a hazardous waste/material is responsible for notifying the spill response/emergency response coordinator. The EC for the 2013 field activities will be the EHS Officer with the Field Team Leader and the RDRA Project Manager as alternates.

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The contingency plan should be reviewed and immediately amended when:

- Changes in applicable regulations occur;
- The plan fails in an emergency;
- Changes are made to emergency procedures;
- Changes occur in emergency personnel list; or
- Changes occur in emergency equipment list.

6.4 PRE-TRANSPORTATION REQUIREMENTS

Prior to transporting hazardous wastes or offering hazardous wastes for transportation off-site, the generator must comply with the following:

- Package the hazardous wastes in DOT-approved containers per 49 CFR Parts 173, 178 and 179. DOT-approved containers (such as drums) are usually marked as being DOT-approved);

- Label the hazardous wastes according to DOT labeling requirements per 49 CFR Part 172;

- Mark each container (of 110 gallons or less) used in transportation with the following:

  HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the EPA.

  - Generator's Name and Address

  - Manifest Document Number

- Ensure that the initial transporter placards the transport vehicle with the appropriate placard in accordance with 49 CFR Part 172 Subpart F.

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6.5 MANIFESTING OFF-SITE SHIPMENTS OF HAZARDOUS IDW

Any generator which transports or offers for transportation hazardous waste for off-site treatment, storage or disposal must prepare a manifest according to manifest instructions for each shipment of similar hazardous wastes. The manifest must be carefully filled out with each shipment. Take care to follow the instructions and use the terms as listed in the instructions. A generator must designate on the manifest one facility (designated facility) which is permitted to handle the waste described on the manifest (40 CFR 262.20).

The generator must determine if the state to which the wastes are destined (consignment state) requires use of its own manifest. If so, then the consignment state's manifest must be used. If the consignment state does not require use of its manifest, and the state in which the waste shipment originates (generator state) does, then the manifest from the generator state must be used. If both states have manifests, use the consignment state manifest, making sure that there are sufficient copies to meet the generator state distribution requirements. If neither state requires use of its manifest, then any uniform hazardous waste manifest may be used (40 CFR 262.21).

The manifest must contain at least enough copies such that the generator gets two copies, the transporter gets one copy and the designated facility gets one copy. Some states require additional copies to be sent to the state. At the time of shipment, the generator must keep one copy (the generator copy) of the completed, signed manifest and give the remaining copies to the transporter. Each copy must have the signature of the generator and the transporter at the time of shipment. The original manifest shall be returned to the generator once the shipment reaches the designated facility and the manifest is signed by the designated facility (40 CFR 262.21).

If the original, signed manifest is not received by the generator within a certain number of days, action by the generator is required. These requirements are discussed in the following sections:

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- If, after 35 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must contact the transporter and/or the designated disposal facility to determine the status of the hazardous waste (40 CFR 262.42(a)(1)).
- If after 45 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must submit an exception report to the U.S. EPA (or authorized state). The exception report must include a copy of the manifest along with an explanation of efforts to locate the hazardous wastes and the result of these efforts (40 CFR 262.42(a)(2)).

6.6 PERSONNEL TRAINING

Any person, and their immediate supervisor(s), involved in waste management at a LQG facility which stores hazardous waste in a 90-day storage area must undergo initial and annual training for hazardous waste management (40 CFR 262.34(a)(4) and 40 CFR 265.16). Facility personnel are required to successfully complete a program of classroom instruction or on-the-job training that teaches them to perform hazardous waste management duties relevant to their jobs. The program must be directed by a person trained in hazardous waste management procedures.

The training must be designed to enable personnel to effectively respond to emergencies by becoming familiar with emergency procedures, emergency equipment and emergency systems, including the following;

- Procedures for using, inspecting, repairing and replacing facility emergency and monitoring equipment;
- Communications or alarm systems;
- Response to fires or explosions; and
- Off-site communication.

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Employee training is to be held at regular intervals. Emergency planning information, e.g., the Contingency Plan, also should be provided to state and local emergency response agencies at regular intervals (40 CFR 265.37 and 265.53). Employees required to receive the training cannot work unsupervised until they have completed the training requirements (either classroom or on-the-job training). In addition, facility personnel must take part in an annual review of the initial training.

The following records must be maintained at the facility for employees affected by this training:

- Job title for each position and name of employee filling each job;
- Job descriptions for each position related to hazardous waste management;
- Written description of type and amount of initial and continuing training that will be given to each person filling the various job positions; and
- Documentation that necessary training has been given and completed by each affected personnel.

Training records are required to be kept on current personnel until closure of the facility. For former employees, training records must be kept for at least three years from the date the employee last worked at the facility and may be transferred if the employee stays within the same company (40 CFR 265.16(e).

6.7 REPORTING AND RECORDKEEPING

The following reports are required of a LQG:

- Manifest exception reports as discussed in Section 6.5 above.
- A LQG must submit a Biennial Report to the EPA (or authorized state) every even numbered year by March 1, e.g., March 1, 2008 for the 2007 reporting year. The Biennial Report is to be submitted on EPA form 8700-13A.

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The following records are required to be kept for a minimum of three years by the LQG:

- The signed original manifests;
- Biennial reports;
- Exception reports;
- All records pertaining to hazardous waste determinations; and
- Land disposal determination records, notification and certification records.

7.0 REFERENCES

EPA, 1991. Management of Investigation-Derived Wastes During Site Inspections, EPA May 1991, EPA/540/G-91/009

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STANDARD OPERATING PROCEDURE 5

SOIL BORING AND DRILLING

This SOP has been revised from SOP No. 10 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007.*

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STANDARD OPERATING PROCEDURE 5

SOIL BORING AND DRILLING

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1.0 INTRODUCTION

This standard operating procedure (SOP) provides a description of the principles and applicability of standard soil boring drilling procedures used during field investigations. Soil borings are typically installed to collect soil samples for chemical or geotechnical purposes, to collect subsurface stratigraphic information, and to install vadose zone or groundwater monitoring wells. For the purpose of this investigation, soil borings will be used to collect soil samples and for geological logging of the soil.

This SOP focuses on methods and equipment that will be used at the FMC facility for this investigation. It is not intended to provide an all-inclusive discussion of soil boring drilling methods. It is anticipated that soil borings will not be completed below the shallow groundwater aquifer. The methods discussed include hollow-stem auger, hand-auger, air percussion hammer and air rotary. All drilling locations at FMC shall be cleared by FMC and any drilling locations off FMC shall be cleared by Idaho Dig Line as described in SOP-1.

In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions. Note that the SWHASP Section 3.2.8 requires that an excavation permit (see Appendix C of the SWHASP) be completed prior to any excavation, digging, or drilling to a depth greater than 18 inches.

2.0 DEFINITIONS

Air Percussion Hammer: Dual walled steel pipe is driven into the ground by using a diesel piston drive head. Soil within the drill pipe is evacuated up through the center of the drill steel with compressed air. Split-spoon soil samplers can be driven with a hammer inside the drill steel.

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Cuttings: Formation particles removed from a borehole during the drilling process.

Drilling Fluids or Muds: A water-based or air-based fluid used in the soil boring operation to remove cuttings from the borehole, to clean and cool the bit, to reduce friction between the drill string and the sides of the borehole, and to seal and stabilize the borehole.

Flight: An individual auger section, typically 5 feet in length.

Hand Auger: A hand auger is typically a 2-inch diameter hollow shaft with a handle used to turn the hand auger. Soil is retrieved from the boring by extracting the hand auger.

Heaving Formation: Unconsolidated, saturated substrate encountered during drilling where the hydrostatic pressure of the formation is greater than the borehole pressure causing the substrate to move up into the borehole.

Hollow-stem Auger: An auger flight is typically a hollow tubular steel center shaft around which is welded a continuous steel strip in the form of a helix. A center bit is used inside the auger to prevent soil from entering the hollow-stem auger. Split-spoon soil samplers can be advanced with the hollow-stem augers or driven with a hammer inside the hollow-stem augers.

Split-Spoon Sampler: A thick-walled, steel tube split lengthwise that is used to collect soil samples. The split-spoon sampler is commonly lined with brass or stainless steel sample sleeves and is driven or pushed down the hole by the drill rig to collect samples.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.),

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and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Selects site-specific drilling methods with input from other key project staff and FMC personnel. Prepares technical provisions for drilling subcontracts.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Implements the field program and supervises other field staff. Prepares daily logs of field activities.

Field Technician (or other designated personnel): Assists the FTL and/or geologist, hydrogeologist, or engineer in the implementation of field tasks.

4.0 DRILLING METHODS

A field log shall be maintained during all drilling activities. Drilling methods can be separated into two general types; techniques that do not use circulating fluids and techniques that use circulating fluids. Soil samples will be collected for analytical data from composite samples and discrete samples as described in the Work Plan and Field Sampling Plan. The following sections discuss the drilling methods that fall into each of these two general categories.

4.1 DRILLING METHODS WITHOUT CIRCULATING AIR

Hand Auger: A hand auger typically cuts a 2-inch diameter and, depending on the geologic materials, up to 15-foot deep borehole, though typically the borehole is less than 10 feet. Generally, the borehole cannot be advanced below the water table because of collapse.

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Applications

- Shallow (up to 15 feet deep) soil investigations
- Pre-drilling for utilities and other subsurface objects
- Soil sampling for stratigraphic logging
- Used in fine grained soil (clay and silt).

Limitations

- Limited to very shallow depths
- Unable to penetrate dense or gravelly soil
- Labor intensive.

Hollow-Stem Augers: Hollow-stem augers are commonly used in unconsolidated materials up to 150 feet in depth. A key advantage of hollow-stem auger drilling is that undisturbed soil samples can be collected through the augers, which act as a temporary outer casing during soil boring drilling.

Hollow-stem augers consist of two parts: a tube with flights attached to the outside and connected to the lead auger, and a center rod and bit which prevents soil from entering the center of the auger. The removable inner plug is the primary advantage of this drilling method. Withdrawing the center bit while leaving the auger in place provides an open, cased hole into which soil samplers, down-hole drive hammers, instruments, casing, wire, pipe, or numerous other items can be inserted. Replacing the center bit allows for continuation of the borehole.

Hollow-stem augers are specified by the inside diameter of the hollow stem, not by the hole size it drills. Hollow-stem augers are available in a variety of inside diameters, such as 2.5, 3.25, 3.375, 4.0, 4.25, 6.25, 6.625, 8.25, and 10.25 inches. The most commonly used inside-diameter for soil borings is a 4.25-inch auger with an 8-inch outer diameter.

The rotation of the augers causes the cuttings to move upward, which can be "smeared" along the borehole walls. This smearing may effectively seal off the upper zones, thereby

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reducing the possibility of cross contamination of the upper zones to the deeper zones but increases the possibility of deep to shallow contamination. Conversely, smearing of clays on the borehole walls may seal off aquifers to be monitored.

Applications

- Suitable for soil investigations with soils ranging in consistency from clay to fine gravel
- Allows good soil sampling with split-spoon samplers
- Can serve as temporary casing
- Can be used in stable formations to set surface casing.

Limitations

- Difficulty in preserving sample integrity in heaving formations
- Formation invasion by water or drilling mud if used to control heaving
- Possible cross contamination of aquifers where the annular space is not positively controlled by water, drilling mud or surface casing
- Limited diameter of augers limits casing size
- Smearing of clays may seal off aquifer to be monitored.

4.2 DRILLING METHODS WITH CIRCULATING AIR

Many drilling techniques use a circulating fluid, such as water, drilling mud, air, a combination of air and water, or even a surfactant to create foam, to aid in the removal of cuttings. Circulating with air is the most common method, while using water, drilling mud or other techniques are generally used when air will not work. The air percussion hammer and air rotary utilizes compressed air through the drill pipe to bring the soil to the surface.

Dual-Walled Percussion Drilling: Dual-walled percussion drilling drives the drill pipes and does not rotate during drilling. The two concentric drive pipes are driven into the ground with a diesel driven percussion hammer. The hammer is similar to the mechanisms mounted on pile drivers. The typical outside diameter of the outer drive pipe

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is 9 inches. The typical inside diameter of the inner pipe, where well materials are normally inserted, is 4.25 inches. The typical drive bit size is 10 inches in diameter. Larger drill bits and drill pipe are available. It is effective to depths up to about 250 feet.

The outer pipe effectively seals off the formation while drilling, reducing the chance of cross contamination. Air is pumped between the annulus of the two pipes to the bit where it is deflected upward into the inner pipe. Cuttings are transported to the surface through the inner pipe.

Applications

- Very rapid drilling through unconsolidated formations
- Allows continuous sampling for lithologic logging in all types of formations
- Representative samples can be obtained with minimal risk of contamination of sample and/or water bearing zone
- Soil samples can be easily obtained for chemical analysis.

Limitations

- Air may modify chemical or biological conditions; recovery time is uncertain.
- Not suitable for cobbles, boulders, or bedrock or consolidated formations

Air Rotary: Air rotary drilling utilizes compressed air to drive a rotating hammer attached to the drill pipe. Air rotary drilling is commonly used for drilling in coarse grained unconsolidated materials and in bedrock up to 500 feet in depth. There are two type of air rotary drilling that are typically used. The first is using dual-walled drill pipe and an air driven rotary hammer. Cuttings are evacuated up through the inner pipe and discharged through a cyclone that is typically mounted on the drill rig. The second type of air rotary drilling is referred to as a conventional air rotary where a single drill pipe supplies compressed air to a rotating drill bit. The soil is brought to the surface with compressed air between the drill pipe and the boring sidewall. Both methods can be used in unconsolidated and consolidated material but are recommended for coarse grained material including cobbles and boulders. In loose formations where the soil boring can

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collapse, protective casing can be installed. Split-spoon soil samplers can be driven with an automatic hammer or drop hammer inside the casing or open borehole after the drill pipe and hammer have been removed. The typical outside diameter of the drill pipe is 3 - 5 inches in diameter and the hammer is typically about 8 inches in diameter, although larger hammers are available.

Applications

- Drilling through coarse grained unconsolidated formations and consolidated formations
- Drilling in coarse unconsolidated material including coarse gravel, cobbles, boulders.

Limitations

- Introduction of air into the formation may modify chemical or biological conditions
- Not suitable for fine grained soil (clay and silt)

4.3 BOREHOLE ABANDONMENT PROCEDURES

A geologist, hydrogeologist, or engineer shall supervise the abandonment activities and shall record details in the field notebook and on page 1 of the Soil Boring Log Form. Soil borings shall be abandoned as described below.

- For soil borings less than 10 feet below ground surface (bgs) or soil borings to native soil (approximately 10 to 20 feet bgs), the borehole will be abandoned with soil cuttings extracted from the soil boring, with the fill material being placed in the soil boring last.
- For soil borings to the groundwater interface, the borehole will be abandoned with hydrated bentonite chips or a bentonite slurry to ground surface.
- The bentonite chips or bentonite slurry will be placed into the soil boring through the hollow-stem augers or drill pipe.

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- As the hollow-stem augers or drill pipe is extracted from the soil boring, source water is added to hydrate the bentonite chips.
- After the bentonite has been hydrated and either the hollow-stem augers or drill pipe have been removed, the boring fill will be checked for settlement. If settlement occurs additional bentonite will be added to the soil boring until no settlement is observed.
- The uppermost one to two feet of the abandoned soil boring shall consist of native material, concrete or asphalt to match the surrounding ground surface.

4.4 BOREHOLE REFUSAL CRITERIA

Certain types of subsurface conditions, (e.g., debris, boulders, coarse gravel layers, and bedrock), may halt the advancement of soil borings depending on the drilling method in use. In such cases, the borehole shall be abandoned in accordance with the methods described in Section 4.3. The new soil boring location may be subject to clearance requirements by FMC if on FMC property and by Idaho Dig Line if off site. The drilling subcontractor has the final authority in determining when refusal has occurred.

4.5 SITE CONDITIONS

Site conditions can limit the drilling methods available for a particular program. Site conditions to be considered include ease of access and applicable requirements, as well as surface and subsurface conditions. Issues relating to site access by the drilling equipment, clearance of overhead obstacles including power lines, roof awnings, and overhead piping shall be considered in the selection of drilling methods and equipment.

Surface Conditions: Surface conditions can affect access to the site and the amount of available workspace (horizontal, vertical or overhead space). These in turn can affect the selection of a particular method or type of drill rig. Limited access and work space may require smaller or remotely powered drill rigs. The site terrain is also an important factor in choosing the drilling method as it may prove to be expensive and difficult to mobilize large and/or heavy equipment over rugged terrain. For such sites, drill rigs (typically hollow-stem auger) are usually mounted on all-terrain equipment.

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In addition to access and workspace, the work environment shall also be considered. This includes both weather conditions and other site activities. Extremely hot or cold climates may require use of special drilling equipment or methods. Sites where explosive atmospheres are likely to exist may require special consideration. All site activities shall be considered as they may impact the selection of the drilling method.

Subsurface Conditions: The subsurface stratigraphy of a site is a fundamental consideration when selecting a particular drilling method. The drilling equipment selected shall be capable of effectively and economically penetrating the strata at the site to meet the project data quality objectives. Particular stratigraphy which may pose problems for certain drilling methods include tight clayey soils, swelling clays, flowing sands, caliche, gravels, cobbles, lost circulation zones, and bedrock.

4.6 WASTE GENERATION

Drilling operations typically generate significant volumes of waste that must be handled, stored, and eventually disposed. This is of particular concern when drilling into contaminated or hazardous subsurface environments. The type and volume of wastes generated during drilling differs for different drilling methods. For details on investigation-derived waste (IDW) refer to SOP-7, Investigation-Derived Waste Management.

5.0 REFERENCES

Driscoll, F.G., 1987, Groundwater and Wells: Second Edition, Johnson Division, St. Paul, Minnesota.

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STANDARD OPERATING PROCEDURE 6

TRENCHING AND TEST PITS

This SOP has been revised from SOP No. 11 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 6

TRENCHING AND TEST PITS

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1.0 INTRODUCTION

This standard operating procedure (SOP) describes methods and equipment commonly used for conducting trench and test pit excavations at hazardous waste sites. Shallow test pits and trench excavations are used to: 1) permit both lateral and vertical examination of subsurface conditions, 2) provide access for collecting shallow soil and groundwater samples, and 3) provide a means of determining the orientation of discontinuities in the subsurface.

In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions. Note that the SWHASP Section 3.2.8 requires that an excavation permit (see Appendix C of the SWHASP) be completed prior to any excavation, digging, or drilling to a depth greater than 18 inches.

2.0 DEFINITIONS

Angle of Repose: This is the steepest slope at which very loosely packed sand is stable. It represents the angle of internal friction of the granular material at its loosest state.

Trench or Test Pit: Linear excavation of varying width and depth, usually used for lateral and vertical examination of subsurface conditions, collection of soil and groundwater samples, and to provide a means of determining the orientation of discontinuities in the subsurface.

Ground Crew: Team consisting of excavating support crew and sampling crew.

Type A Soil: Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) or greater. Examples of this type of soil are clay, silty clay, sandy clay, and clay loam.

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Type B Soil: Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (43 kPa), but less than 1.5 tsf (144 kPa); or

- Granular, cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam;
- Previously disturbed soils, except those which would otherwise be classified as Type C soil (see below);
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration;
- Dry rock that is not stable;
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less than 4:1, but only if the material would otherwise be classified as Type B.

Type C Soil: Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

- Granular soils including gravel, sand, and loamy sand;
- Submerged soil or soil from which water is freely seeping;
- Submerged rock that is not stable;
- Material in a sloped, layered system where the layers dip into the excavation on a slope of 4:1 or steeper.

Unconfined Compressive Strength: The load per unit area at which a soil will fail in compression. It can be estimated in the field using a pocket penetrometer, or by testing in a materials testing laboratory.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.),

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and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Selects site-specific trenching/test pit program and sampling methods with input from other key project staff and FMC personnel. Oversees preparation of heavy equipment subcontract.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Implements trenching/test pit program and supervises other sampling personnel. Prepares daily logs of field activities.

Field Technician (or other designated personnel): Assists the FTL and/or field geologist, hydrogeologist, or engineer in the implementation of field tasks.

4.0 TRENCH AND TEST PIT CONSTRUCTION

4.1 GENERAL

Trench and test pit excavations are typically carried out by motorized equipment such as rubber tires backhoes and track mounted excavators. Operators of excavating equipment shall be skilled and experienced in safe use of the equipment. A typical backhoe with an extending arm can excavate to a depth of approximately 15 feet. If investigations are required to penetrate beyond 15 feet, test pits may not be the most appropriate method of investigation and the use of other methods (e.g., soil borings) should be considered.

Safety Requirements and Procedures: Safety is perhaps the most critical consideration in any excavation project. This SOP does not address compliance with the regulations of the Occupational Safety and Health Administration (OSHA). Those issues shall be addressed in project-specific health and safety plans. Prior to all excavations, the FTL must confirm that any underground utilities (electric, gas, telephone, water, etc.) in the general vicinity have been clearly identified.

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During excavation activities, standard hand signals shall be used for rapid and efficient communication between the backhoe operator and the ground crew. Before approaching the test pit or excavating machine, the ground crew must ascertain that the equipment operator has noted their presence and has stopped operation of the equipment.

Upon locating the area for excavation, the FTL shall determine wind direction and position the excavator upwind of the pending excavation. The backhoe operator shall outline the area of investigation by extending the bucket arm to its maximum length, and tracing a 180-degree outline around the area to be excavated to create the exclusion zone. The support crew shall cordon off the exclusion zone with barricades and brightly colored "caution" tape.

Once the equipment has been appropriately positioned, excavation can commence. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator shall scrape the initial 6 inches of topsoil to allow a clear and safe working area. In areas with no ground cover, any excavated fill material shall be stockpiled away from the immediate edge and away from the native soil to be excavated and sampled. The excavated native soil will be placed on clean plastic or native soil in 2-foot lifts. Both fill material and native soil shall be placed away from the trench to prevent excavated soil from re-entering the trench or pit, and to reduce pressure on the sidewalls. Sidewalls of the excavation may be sloped in loose soils to stabilize the sidewalls and prevent caving.

Excavated soil shall be stockpiled downwind of the ground crew and the equipment operator. Shifting winds may cause the equipment operator and ground crew to periodically move in order to remain upwind, or to curtail further activities. The support crew shall regularly monitor the equipment operator and ground crew's airspace.

Material brought to the surface and handled shall be disposed of in accordance with procedures outlined in SOP-7 (Investigation-Derived Waste [IDW] Management).

Entry of personnel into pits or trenches is restricted unless specifically approved by the site-specific health and safety plan, and special precautions and accommodations are provided. Strict adherence to state and federal Occupational Safety and Health

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Administration (OSHA) trenching guidelines (29CFR 1926.650) shall be observed. Under this standard, when personnel are required to enter an excavation 5 feet deep or more, adequate means of exit such as ladders, steps, ramps, and other full lateral support of the sidewalls must be provided and be within 25 feet of lateral travel. In addition, personnel entering the trench may be exposed to toxic, explosive, or oxygen-deficient atmospheres. Air monitoring can be performed before and during entry, and appropriate respiratory gear and protective clothing can be worn, if necessary. Caution must be exercised at all times and at least two people must be present at the immediate site (OSHA, 1990).

Care shall be taken to ensure that personnel do not stand too close to the edge of the trench, especially during sampling or depth measurements. The added weight of a person adjacent to the pit can increase the risk of sidewall failure.

Stability: Depending on the desired depth of excavation, the trench may require shoring (lateral support) to prevent the sides from collapsing. Lateral support may be provided by a portable aluminum frame system that uses a hydraulic pump to apply pressure to the sidewalls and that can be quickly inserted or extracted, or the sides benched to an appropriate angle. Only skilled personnel shall install timber supports or any other alternative support required in excavations.

Although personnel shall normally not be required to enter the excavation, it is important to know the possible behavior of the various soil types and conditions that may be encountered. Excavations in fill are generally much more unstable than those in native soil. The table below indicates maximum allowable slopes for different soil types (Federal Register, Rules and Regulations, Vol. 84, October 1989).

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MAXIMUM ALLOWABLE SLOPES

Soil or Rock Type	Maximum Allowable Slope (H:V) for Excavations Less Than 20 Feet
Stable Rock	Vertical (90 degrees)
Type A	3/4:1 (53 degrees)
Type B	1:1 (45 degrees)
Type C	11/2:1 (34 degrees)

The numbers shown above in parentheses, next to the maximum allowable slopes (MAS), are angles measured from the horizontal. In addition, a short-term MAS of ½:1 (63 degrees) is allowed in excavations in Type A soil that are 12 feet or less in depth. Short-term MAS for excavations in Type A soil greater than 12 feet in depth are ¾:1 (53 degrees). Sloping or benching for excavations greater than 20 feet in depth shall be designed by a registered professional engineer.

Excavations in very soft, normally consolidated clay should stand vertically, without support, to depths of approximately 12 feet in the short term only. This critical depth increases as the clays increase in consistency. Long-term stability is dependent on a combination of factors including the soil type, pore water pressures, and other forces acting within the soil. Fissured clays can fail along well-defined shear planes and, therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose regardless of the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Damp sands and gravel possess some cohesion and can stand vertically for a short period of time. However, the stability of water-bearing sands is very difficult to predict in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the

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face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts should stand unsupported vertically, especially if slightly cemented. Saturated silt is the most difficult material to excavate. Seepage of water into excavations in silt leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be assumed that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes or joints, and the degree of fracturing. Unstable conditions can occur if bedding planes or joints slope steeply towards the excavation, especially in the presence of groundwater.

4.2 FIELD RECORDING AND SAMPLING TECHNIQUES

The field record shall include a field form giving the location, dimensions, and orientation of the pit or excavation, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing performed. Working from the ground surface, the technician or other designated personnel shall prepare a visual log of the strata/soil profile and decide the sampling interval. If possible, a photographic record of the excavation, with an appropriate scale, shall be obtained.

Any groundwater encountered shall be noted with regard to its depth and approximate rate of seepage. If possible the groundwater level within the test pit should be monitored for 20 minutes, with readings taken at 5-minute intervals.

Soil samples from excavations can be either disturbed or undisturbed. Soil sample collection methods and procedures are described in SOP 14. Details of sample collection shall be provided in site-specific sampling plans.

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4.3 BACKFILLING

Test pits or trenches shall be backfilled immediately upon completion of the excavation and soil sampling, or at a time determined by the Project Manager. Excavated material, including fill material will be placed back into the excavation in the order it was removed. During backfilling, the excavated material will be compacted in one- or two-foot lifts with the backhoe or excavator bucket. The backfilled material will be compacted to prevent settling of soil.

SECTION 5.0 REFERENCES

Excavations; U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 1990 (Revised).

Federal Register, Rules and Regulations, Vol. 84, No. 209, October 1989.

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STANDARD OPERATING PROCEDURE 7

SOIL CLASSIFICATION

This SOP has been revised from SOP No. 8 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

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STANDARD OPERATING PROCEDURE 7

SOIL CLASSIFICATION

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1.0 INTRODUCTION

This standard operating procedure (SOP) is intended for use as a guide for soil logging procedures at sites requiring subsurface investigation. The SOP employs the Unified Soil Classification System (USCS) and the ASTM Standard D 2488 - 90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure; ASTM, 1990). A thorough working knowledge of this SOP is critical for field personnel to standardize logging procedures and to enable subsequent correlation between borings at a site, allowing for accurate site characterization.

The information described in this SOP is summarized on the USCS chart in Attachment A. Laminated copies of this chart shall be available for all field personnel. Other field references may also be used according to personal preference. However, such references shall be based on the USCS.

2.0 DEFINITIONS

Use of the USCS requires familiarity with the grain size ranges that define a particular type of soil, as well as several other physical characteristics. The grain size definitions and physical characteristics upon which soil descriptions are based are presented below.

2.1 GRAIN SIZES

USCS grain sizes are based on U.S. standard sieve sizes, which are defined as follows:

- Standard sieves with larger openings are named according to the size of the openings in the sieve mesh. For example, a "No.3" sieve contains 3 openings per square inch.
- Standard sieves with smaller openings are given numbered designations that indicate the number of openings per square inch. For example, a "No. 4" sieve contains 4 openings per square inch.

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The following grain size definitions are paraphrased from the ASTM Standard D 2488 - 90. Field personnel shall familiarize themselves with the grain size definitions and refer to the appropriate field guide for a visual reference.

Boulders: Particles of rock that will not pass a 12-in. (300-millimeter [mm]) square opening.

Cobbles: Particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. or 75 mm sieve.

Gravel: Particles of rock that will pass a 3-in (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

Coarse Gravel: Passes a 3-in. (75-mm) sieve and is retained on a 3/4-in. (19-mm) sieve

Fine Gravel: Passes a 3/4-in. (19-mm) sieve and is retained on a No. 4 (0.19 in. or 4.75-mm) sieve

Sand: Particles of rock that will pass a No. 4 (0.19 in. or 4.75-mm) sieve and be retained on a No. 200 (0.0029 in. or 75-micrometer [μm]) sieve with the following subdivisions:

Coarse Sand: Passes a No. 4 (0.19 in. or 4.75-mm) sieve and is retained on a No. 10 (0.079 in. or 2-mm) sieve

Medium Sand: Passes a No. 10 (0.079 in. or 2-mm) sieve and is retained on a No. 40 (0.017 in. or 425-μm) sieve

Fine Sand: Passes a No. 40 (0.017 in. or 425-μm) sieve and is retained on a No. 200 (0.0029 in. or 75-μm) sieve

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Silt: Soil passing a No. 200 (0.0029 in. or 75-μm) sieve that is non-plastic or very slightly plastic, and that exhibits little or no strength when air-dried. Individual silt particles are not visible to the naked eye.

Clay: Soil passing a No. 200 (0.0029 in. or 75-μm) sieve that can be made to exhibit plasticity within a range of moisture contents, and that exhibits considerable strength when air-dried. Individual clay particles are not visible to the naked eye.

2.2 PHYSICAL CHARACTERISTICS

The physical characteristics described below are used in the USCS classification for fine-grained soils. Physical characteristics of coarse-grained soils and consolidated rock are presented in Section 4.2. A brief definition of each physical characteristic is presented including a description and criteria. However, with the exception of plasticity, the criteria for the field tests are generally too time-consuming to perform regularly in the field. A determination of the type of fine-grained soil present in the sample can generally be made on the basis of plasticity, as described in Section 4.1.2.

Dry Strength: The Dry Strength is described as the ease with which a dry lump of soil crushes between the fingers.

Description	**Criteria**
None:	The dry specimen crumbles into powder with mere pressure of handling.
Low:	The dry specimen crumbles into powder with some finger pressure.
Medium:	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High:	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.

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Very High:	The dry specimen cannot be broken between the thumb and a hard surface.

Dilatancy Reaction: Dilatancy reaction is described at the speed with which water appears in a moist part of soil when shaken in the hand, and disappears while squeezing.

Description	Criteria
None:	No visible change in the specimen.
Slow:	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid:	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

Toughness: Toughness is described as the strength of a soil, moistened near its plastic limit, when rolled into a 1/8-in. diameter thread.

Description	Criteria
Low:	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.

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Medium:	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High:	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

Plasticity: Plasticity is described as the extent to which a soil may be rolled into a 1/8 in. thread, and re-rolled when drier than the plastic limit.

Description	Criteria
Nonplastic:	A 1/8-in. (3-mm) thread cannot be rolled at any water content.
Low:	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium:	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High:	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often additional

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personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Defines objectives of fieldwork. Prepares drilling and sampling plans with input from the Project Hydrogeologist/Field Team Leader. Oversees and prepares subcontracts.

RDRA Field Team Leader (FTL) and/or Project Hydrogeologist, Geologist, or Engineer: Implements field program. Records and reviews boring logs. Supervises drilling subcontractor. Prepares daily logs of field activities.

4.0 SOIL LOGGING PROCEDURES

The following aspects of a project shall be considered before sampling and soil logging commences. This information is generally summarized in a project-specific work plan or field sampling plan, which shall be thoroughly reviewed by all field personnel prior to the initiation of work.

- Purpose of the soil logging (e.g., initial investigation, subsequent investigation, remediation, etc);
- Known or anticipated hydrogeologic setting including stratigraphy (i.e., consolidated/unconsolidated, depositional environment, presence of fill material, etc.), physical characteristics of the aquifer (porosity/permeability), type of aquifer (confined/unconfined), recharge/discharge conditions, aquifer thickness and groundwater/surface water interrelationships;
- Drilling conditions
- Previous soil boring or borehole geophysical logs (these should be carried to the field for reference)
- Soil sampling and geotechnical testing program

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- Characteristics of potential chemical release(s) (i.e., chemistry, density, viscosity, reactivity, and concentration, etc.)
- Health and Safety requirements
- Regulatory requirements

The procedures used to determine the correct soil sample classification are described below.

4.1 FIELD CLASSIFICATION OF SOILS

The following soil classification procedures are based on the ASTM Standard D 2488 - 00 for visual-manual identification of soils (ASTM, 2000). When identifying soils, the proper USCS soil group name is given, followed by the group symbol. For clarity, the group symbol shall be placed in parentheses after the written soil group name. Alternatively, a separate column may be designated for the group symbol.

Soil identification using the visual-manual procedures is based on naming the portion of the soil sample that will pass a 3-in. (75-mm) sieve. Therefore, before classifying a soil, any particles larger than 3 inches (cobbles and boulders) shall be removed, if possible. The percentage of cobbles and boulders shall be estimated and recorded.

Using the remaining soil, the next step of the procedure is to estimate the percentages, by dry weight, of the gravel, sand, and fine fractions (particles passing a No. 200 sieve). The percentages shall be estimated to the closest 5 percent. In general, the soil is *fine-grained* (e.g., silt or clay) if it contains 50 percent or more fines, and *coarse-grained* (e.g., sand or gravel) if it contains less than 50 percent fines. If one of the components is present but estimated to be less than 5 percent, its presence is indicated by the term *trace*. For example, 'trace of fines' shall be added as additional information following the formal USCS soil description.

Procedure for Identifying Coarse-Grained Soils: If the sample has been determined to contain less than 50 percent fines, the soil may be classified as either *gravel* (if the

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percentage of gravel is estimated to be more than the percentage of sand), or *sand* (if the percentage of gravel is estimated to be equal to or less than the percentage of sand).

If the soil is predominantly sand or gravel but contains an estimated 15 percent or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "gravel with sand (GP)." If the sample contains any cobbles or boulders, the words "with cobbles" or "with cobbles and boulders" shall be added to group name. For example: "silty gravel with cobbles (GM)".

5 Percent or Less Fines: The soil is a 'clean gravel' or 'clean sand' if the percentage of fines is estimated to be 5 percent or less. 'Clean' is not a formal USCS name, but rather a general descriptor for implying little to no fines. Clean sands and gravels are given the USCS designation as either *well graded* or *poorly graded*, as described below.

The soil sample is *well-graded gravel* (GW), or *well-graded sand* (SW), if it has a wide distribution of particle sizes and substantial amounts of the intermediate particle sizes. On the other hand, the soil sample is a *poorly-graded gravel* (GP) or *poorly-graded sand* (SP) if it consists predominantly of one grain size (uniformly graded), or has a distribution of sizes with some intermediate sizes obviously missing (gap- or skip-graded).

<u>NOTE:</u> When using the USCS, keep in mind the differences between grading and sorting. The term grading is used to indicate the size class of particles contained in the sample, while sorting refers to the range of the particle sizes on either side of the average particle size. For example, poorly-graded sand containing predominantly one grain size would be considered well-sorted, and vice-versa. One notable exception to this general rule is a skip-graded (bi-modally distributed) sample: sand containing two distinct grain sizes would be considered both poorly-sorted and poorly-graded. The USCS uses only the *GRADING* descriptor in soil naming, not the sorting descriptor.

15 Percent Fines: If the percentage of fines is estimated to be 15 percent or more, the soil may be classified as *silty or clayey gravel* or *silty or clayey sand*. For example, a soil can be identified as *clayey gravel* (GC) or *clayey sand* (SC) if the fines are clayey, or as

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silty gravel (GM) or *silty sand* (SM) if the fines are silty. The coarse-grained descriptor "poorly-graded" or "well-graded" is not included in the soil name, but rather, shall be included as additional information following the formal USCS soil description.

>5 Percent but <15 Percent Fines: If the soil is estimated to contain greater than 5 percent and less than 15 percent fines, the soil sample shall be designated with a dual identification using two group symbols. The first group symbol shall correspond to the clean gravel or sand portion of the sample (i.e., GW, GP, SW, SP) and the second symbol shall correspond to the clayey/silty gravel or sand portion (i.e., GC, GM, SC, SM). The group name shall correspond to the first group symbol, and include the words "poorly-graded" or "well-graded", plus the words "with clay" or "with silt" to indicate the character of the fines. For example, "poorly-graded gravel with silt" would have the symbol GM, and “poorly graded gravels or gravel-sand mixtures” would have the symbol GP.

Procedure for Identifying Fine-Grained Soils: The USCS classifies inorganic, fine-grained soils according to their degree of plasticity and other physical characteristics defined in Section 2.2 and Tables 9-1 through 9-4 (i.e., soil sample with no or low plasticity is indicated with an "L"; and soil sample with high plasticity is indicated with an "H"). As indicated in Section 2.2, the field tests used to determine dry strength, dilatancy, and toughness are generally too time-consuming to be performed on a routine basis. However, the field test for plasticity can be easily performed. While field personnel shall be familiar with the definitions of the physical characteristics and concepts of the field tests, field classifications shall generally be based primarily on plasticity. NOTE: if precise engineering properties are necessary for the project (e.g., construction or modeling) geotechnical samples shall be collected for laboratory testing. The results of the laboratory tests shall be compared to the field logging results. Characteristic physical properties of fine-grained soils are listed below.

Silt (ML): the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic.

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Lean clay (CL):	inorganic clay soil with medium to high dry strength, no or slow dilatancy, medium toughness, and slightly plastic.
Organic soil (OL or OH):	the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, from black to brown, when exposed to the air. Organic soils normally will not have a high toughness or plasticity.
Elastic silt (MH):	the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity; will air dry more quickly than lean clay and have a smooth, silky feel when dry.
Fat clay (CH):	soil has high to very high dry strength, no dilatancy, and high toughness and plasticity.

Other Modifiers for use with Fine-Grained Soils:

15 Percent to 25 Percent Coarse-Grained Material: If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name. For example: "lean clay with sand (CL)" or "silt with gravel (ML)". If the percentage of sand is equal to the percentage of gravel, use "with sand".

30 Percent Coarse-Grained Material: If the soil is estimated to have 30 percent or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be the same or more sand than gravel.

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Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy silt (ML)", or "gravelly fat clay (CH)".

Procedure for Identifying Borderline Soils: To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example, a soil containing an estimated 50 percent silt and 50 percent fine-grained sand may be assigned a borderline symbol "SM/ML". Borderline symbols shall not be used indiscriminately. Every effort shall be made to first place the soil into a single group and then to estimate percentages following the USCS soil description.

4.2 DESCRIPTIVE INFORMATION FOR SOILS

After the soil name and symbol are assigned, the soil color, consistency/density, and moisture content shall be described <u>in that order</u>. Other information is presented later in the description, as applicable.

Color: Color is an important property in identifying both inorganic and organic soils, and may also be useful in identifying materials of similar geologic or depositional origin in a given location. Munsell Soil Color Charts or Rock Charts shall be used.

When using Munsell Soil Color Charts, use the appropriate color charts to assign the applicable color name and Munsell symbol to a wet soil sample (colors change as moisture content changes, and all color descriptions shall be made on wet soil for consistency). The ability to detect minor color differences varies among people, and the chance of finding a perfect color match in the charts is rare. Keeping this in mind shall help field personnel avoid spending unnecessary time and effort going through the chart pages. In addition, attempts to describe soils in detail beyond the reasonable accuracy of field observations may result in less accurate soil descriptions than would be achieved by simple expression of the dominant colors (Munsell Soil Color Chart, 1992). All soil color information shall be recorded in the field logbook or field forms.

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It should be noted that soil color may also be impacted by contamination. To the extent possible, information pertaining to color impacted by such factors shall also be recorded on the boring logs.

Consistency/Density: Consistency is used to describe fine grained soils (silt and clay) and density is used to describe coarse grained (sand and gravel). Consistency and density can be described based on the blows per foot using a 140-pound hammer dropped 30" or by completing field tests. This and other pertinent information shall be clearly indicated in the field log book on the soil boring-log.

Criteria for Describing Consistency by field test

Consistency (Silt and Clay)	Blows/ft*	Thumb Penetration
Term	2.0" ID	
Very soft:	0-2	Easily penetrated several inches by thumb.
Soft:	2-4	Easily penetrated 1in. (25 mm) by thumb. Molded with light finger pressure.
Medium stiff:	4-9	Can be penetrated ¼ in. (6 mm) by thumb with moderate effort. Molded with strong finger pressure.
Stiff:	9-17	Indented about penetrated ¼ in. (6 mm) by thumb but penetrated only with great effort.
Very stiff:	17-39	Readily indented by thumbnail.
Hard:	39-78	Indented with difficulty by thumbnail.

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Very hard:	>78	Unable to indent with thumbnail.

Density (Sand and Gravel) Blows/ft*	**Blows/ft***	**Thumb Penetration**
Term	2.0" ID	
Very loose:	0-5	Easily penetrated with thumbnail
Loose:	5-12	Easily penetrated with finger pressure
Medium dense:	12-37	Penetrated by strong finger pressure.
Dense:	37-60	Penetrated only slightly by strong finger pressure.
Very dense:	>60	Penetrated only slightly by very strong finger pressure.

Moisture: Moisture condition of the soil shall be described as dry (absence of moisture, dusty, dry to the touch), moist (damp but no visible water), or wet (visible free water, saturated).

Angularity: Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, sub-angular, sub-rounded, or rounded in accordance with the following criteria:

Angular: Particles have sharp edges and relatively planar sides with unpolished surfaces

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Sub-angular: Particles are similar to angular description but have rounded edges

Sub-rounded: Particles have nearly planar sides but have well-rounded corners and edges

Rounded: Particles have smoothly curved sides and no edges.

A range of angularity may be stated, such as "sub-rounded to rounded."

Grain Size: The maximum particle size found in the sample shall be described in accordance with the following information:

Sand Size: If the maximum particle size is a sand size, describe as fine, medium, or coarse. (See Section 2 for sand size definitions.)

Gravel Size: If the maximum particle size is a gravel size, describe the diameter of the maximum particle size in inches.

Cobble or Boulder Size: If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle.

For gravel and sand components, describe the range of particle sizes within each component; for example, "about 20 percent fine to coarse gravel, about 40 percent fine to coarse sand".

Odor: Due to health and safety concerns, NEVER intentionally smell the soil. This could result in exposure to volatile contaminants that may be present in the soil. If, however, an odor is noticed, it shall be described accordingly. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation (sometimes a hydrogen sulfide or "rotten egg" smell). If the odor is determined to be due to the likely presence of petroleum-based products or other

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chemicals, it shall be described as such. Organic vapor readings from organic vapor monitoring equipment shall be noted on the field boring-log. The project-specific health and safety plan shall then be consulted for specific information and guidelines on the appropriate level of protection necessary for the continuation of field activities at the site.

Cementation: Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the following criteria:

Weak:	Crumbles or breaks with handling or little finger pressure
Moderate:	Crumbles or breaks with considerable finger pressure
Strong:	Will not crumble or break with finger pressure.

The presence of calcium or magnesium carbonates may be confirmed on the basis of effervescence with dilute hydrochloric acid (HCl). Proper health and safety precautions shall be followed when mixing, handling, storing, or transporting HCl.

Structure: Structure of intact soils shall be described in accordance with the criteria in Table 9-7.

Lithology/Mineralogy: Describe the lithology (rock or mineral type) of the sand, gravel, cobbles, and boulders, if possible. It may be difficult to determine the lithology of fine and medium-grained sand or particles that have undergone alteration.

Additional Comments: Additional comments may include the presence of roots or other vegetation, fossils or organic debris, staining, mottling, iron and magnesium oxidation, difficult drilling, and caving or sloughing of the borehole walls. Also, when drilling in an area known or suspected to contain imported fill material, every effort shall be made to identify the contact between fill and native soils. If a soil is suspected to be fill, this shall be clearly indicated on the boring log following the soil description. Stratigraphic units and their contacts shall be noted wherever possible.

Bedrock Descriptions: If the soil boring penetrates bedrock, the boring log form shall indicate the rock type, color, weathering, fracturing, competency, mineralogy (including

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secondary mineral assemblages), structure, age (if known), and any other information available. If bedrock drilling is planned, the FTL, with the concurrence of the Project Manager, shall make arrangements to provide the field team with appropriate definitions and other pertinent information that shall be collected.

5.0 REFERENCES

ASTM, 2000, Standard D 2488 - 00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Macbeth, 1992, Munsell Soil Color Charts.

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APPENDIX B

Field Forms

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SOIL SAMPLE LOG FORM

RU Number ______________________ Sample Location I.D. ______________________

Sample I.D. ______________________ Sample Depth ______________________

Sample Collection Date ______________________

Sample Collection Time ______________________

Sample Collected By ______________________

Weather Conditions ______________________

Location Coordinates ______________________

Field USCS Descriptions ______________________

Major Divisions: ❑ OH ❑ CH ❑ MH ❑ OH ❑ CL ❑ ML ❑ SC
❑ SM ❑ SP ❑ SW ❑ GC ❑ GM ❑ GP ❑ GW

Qualifiers: ❑ Trace ❑ Minor ❑ Some; Sand Size ❑ Fine ❑ Medium ❑ Coarse

Moisture: ❑ Dry ❑ Moist ❑ Wet

Munsell Color ______________________

SAMPLE CONTAINER	PRESERVATIVE	ANALYTE	LAB VIAL WEIGHT (± .01 g.)	EMPTY FIELD VIAL WEIGHT (± .01 g.)	FILLED FIELD VIAL WEIGHT (± .01 g.)

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DAILY QUALITY CONTROL REPORT

DATE ______________________

DAY	S	M	T	W	TH	F	S

PROJECT ______________________

JOB NO. ______________________

LOCATION ______________________

CONTRACT NO. ______________________

WEATHER	Bright Sun	Clear	Overcast	Rain	Snow
TEMP	To 32	32–50	50–70	75–85	85 up
WIND	Still	Moder.	High	**Report No.**	
HUMIDITY	Dry	Moder.	Humid		

PERSONNEL AND SUBCONTRACTORS ON SITE:

VISITORS ON SITE:

EQUIPMENT ON SITE:

WORK PERFORMED (INCLUDING SAMPLING):

FILE: FMC Daily Quality.ai 1004503.010505 02/24/2006 SLC

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(Continuation Sheet)

PROJECT ______________________ **REPORT NO.** ______________

JOB NO. ______________________ **DATE** ______________

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):
HEALTH AND SAFETY LEVELS AND ACTIVITIES:
PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:
SPECIAL NOTES:
TOMORROW'S EXPECTATIONS:

DISTRIBUTION : 1. MW PROJECT MANAGER
2. PROJECT FILE

Page ______ of ______

SUBMITTED BY ______________________ **TITLE** ______________

MWH

FILE: Fig 4-1b FMC Daily Quality.ai 1004503.010505 02/24/2006 SLC

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BORING LOCATION	Project: ________ Project No: ________	Boring ID: ________
	Date Drilled: ________ Date Completed: ________ Logged By: ________	Northing: ________ Easting: ________
	Water Elevation (ft.): ________ Date Measured: ________	Ground Surface Elevation (ft.): ________ Datum: NGVD (1988)
	Total Depth (ft.): ________ Diameter (in.) ________	Drilling Contractor: ________ Drilling Method: ________
	Abandonment Information: ________	

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICATION	GRAPHIC LOG	DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)

* C California Split Spoon Sampler (2.5" I.D.)
S Standard penetration test sampler
c Cuttings
▼ Elevation of ground water

PAGE 1 OF ____

FILE: FMC MW Log Form pg 1.ai 1004931.010604 04/03/2007 SLC

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Project: ______________ Project No: ____________________

Boring ID.: _____________

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICAT.	GRAPHIC LOG	DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)

FILE: FMC MW Log Form pg 3.ai 1004931.010604 04/03/2007 SLC

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Project: ______________ Project No: ____________________

Boring ID.: _____________

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICAT.	GRAPHIC LOG	DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)

FILE: FMC MW Log Form pg 2.ai 1004931.010604 04/03/2007 SLC

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MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	LETTER DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 60% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	**CLEAN GRAVELS** (LITTLE OR NO FINES)		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
				GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	Silty gravels, gravel-sand-silt mixtures
				GC	Clayey gravels, gravel-sand-clay mixtures
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	**CLEAN SAND** (LITTLE OR NO FINES)		SW	Well-graded sands, gravelly sands, little or no fines
				SP	Poorly graded sands, gravelly sands, little or no fines
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	Silty sands, sand-silt mixtures
				SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS				PT	Peat, humus, swamp soils with high organic contents

Note: For coarse soils: gravels and sands with 5 to 12 percent fines require dual symbols . Soils 15 percent sand or gravel, add with sand or with gravel. For fine grained soils: If 15 to 29 percent sand or gravel add with sand or with gravel or name. If 30 percent sand or gravel add sandy or gravelly to group name.

UNIFIED SOIL CLASSIFICATION SYSTEM

Adopted by Corps of Engineers and Bureau of Reclamation, January, 1952, in collaboration with A. Casagrande, PhD.

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TRENCH TEST PIT LOG FORM

Project ________________________ Project Number ________________________

Sample Location ________________________ Trench Number ________________________ Date ________________________

Coordinates: Inside Stake ________________________ Outside Stake ________________________

Native/Fill Stake ________________________

Logged By ________________________

TRENCH PROFILE

Depth in Feet

Feet

Subsurface description and filed USCS Classifications
(USCS name, color, size and angularity or plasticity, density, moisture content, additional facts and debris encountered)

____

____

____

____

____

____

____

____

Begin Trench ________________________ Finish Trench ________________________ Trenching Contractor ________________________

Total Depth ________________________ Total Length ________________________

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FILE: Fig___ FMC Trench profile.ai 1004503.010505 03/06/2006 SLC

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GPS BENCHMARK CHECK FORM

Project: ____________________ Project Number: ____________________
Known Coordinate: ____________________

INSTRUMENTATION:
Brand ____________________ Model # ____________________
Coordinate System: NAD_1983_StatePlane_Idaho_East_FIPS_1101_Feet

Date	Time	Northing	Easting	Elevation	Weather	Checked By	Comments

MAINTENANCE AND/OR REPAIR:

Instrument	Problem	Return to Mfg. for Repair	In-House Repair	Type of Maintenance or Repair	Effective	Comments

FILE: GPS Benchmark Elevation form.ai 1004503.010505 02/22/2006 SLC

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